THURSDAY, DECEMBER 10, 1885

THE "ENCYCLOPÆDIA BRITANNICA"

Encyclopædia Britannica. Ninth Edition. Vols. XVIII. and XIX. (Edinburgh: A. and C. Black, 1885.)

THESE two volumes are almost entirely occupied with letter P, and yet it is not finished. Though there are no articles of the tremendous length of some in the earlier volumes, still there are many of more than the average length and importance. In Vol. XVIII. we have such articles as Ornithology, by Prof. Newton; Parallax, by Mr. David Gill; Pacific Ocean, by Mr. John Murray; and Phosphorescence, by Prof. Pritchard. In Vol. XIX. again we have a valuable fragment on the Physical Sciences, by the late Clerk Maxwell; Pisciculture, by Mr. Browne Goode; Planarians, by Prof. L. V. Graaf; Polar Regions, by Mr. C. R. Markham; Physiology, by Prof. M. Foster, Prof. McKendrick, and Mr. S. H. Vines; and Pianoforte, by Mr. A. J. Hipkins. We have only space to notice at length the articles on Ornithology, Physiology, and Pianoforte.

Prof. Alfred Newton's article "Ornithology" stamps him as the first ornithological critic of the day, and his treatment of this most difficult subject is, as far as it goes, a model of scientific arrangement and elegant diction. He traces the history of ornithology from the very earliest times by a record of successive authors and their work, and then discusses the families of birds with a dissertation on the merits of the various systems which have been lately proposed, but it is in the record of recent ornithological work that we find the most conspicuous failure of Prof. Newton to do justice to his contemporaries. Whether want of space compelled the author to abridge this part of the subject we know not, but if the article "Ornithology" is supposed to be a history of the science down to the year 1884, the student of the future will greatly wonder at the omissions, not knowing how to attribute them to a critic whose account of the early history of the subject is so wonderfully complete and minute. It was doubtless a mere oversight on the part of the author to have attributed the completion of Gould's "Supplement to the Humming-birds" to Mr. Salvin instead of to Mr. Sharpe, but we should have expected to find some little account of the publications of the last-named ornithologist, whose name is not mentioned in connection with the "Catalogue of Birds in the British Museum," with which it is likely to be remembered in the history of ornithology, more than with the foundation of Dresser's "Birds of Europe," and with the second edition of Layard's "Birds of South Africa," with which Prof. Newton associates it. In the latter case Mr. Sharpe must be held to have done his work badly, as, despite his incorporation of all the excellent work of Mr. J. H. Gurney in his edition of "Layard," the latter ornithologist has a "knowledge of South African ornithology perhaps greater than that of any one else." No classification of birds as yet proposed satisfies Prof. Newton, any more than it does any other ornithologist; but Mr. Sharpe's publication of Sundevall's scheme of classification will *not* be considered "so much waste of time" by those who recognise that, with all its faults, it contains, like all well-matured schemes, many points of excellence and hints on classification in advance of his predecessors. The same must be said of Dr. Sclater's recent scheme, and also of Prof. Newton's own critical remarks in the present article. All are contributions, towards a final natural arrangement of the class "*Aves*," if such indeed will ever be compassed. The arrangement of the British Museum "Catalogue" is well known to be faulty, but it is only by the complete description of every genus and its component species that a correct idea of their relations can ultimately be entertained, and to entirely ignore the new volumes of the "Catalogue" is at least matter for wonderment, seeing that already 4116 species have been described in its pages with their full synonymy up to date, while 196 species have been figured. Similarly Prof. Newton, in his enumeration of recent works on British ornithology, omits to mention Mr. Seebohm's name altogether, though the "History of British Birds" was far advanced towards completion in 1884. We might also complain of the scant justice done to Mr. Harting, whose popular work on the "Birds of Middlesex" was the forerunner, if not the exact model, of many of those books on county ornithology, space to mention which is found by Prof. Newton. No doubt some future historian will carry on the record of ornithological prowess from the point where it is left by Prof. Newton, but one thing is certain, that every subsequent writer will be indebted to the author for his facts concerning the early history of ornithology, which we believe to be one of the most complete and exhaustive records ever published.

The article "Physiology" in the last-issued volume is a threefold one of considerable length. Dr. Vines gives us an extended treatise on vegetable physiology, whilst Prof. McKendrick discusses in detail certain aspects of the physiology of the nervous system. Without detracting from the merit of these two pieces of work, which are full of valuable information, we may say at once that the section of the article written by Prof. Michael Foster, which precedes these, is that which will command most attention and indeed should be read by every student of science as well as by the intelligent layman who wishes to know the past, present, and future of the branch of science which is, perhaps more than any other, destined to influence the welfare of humanity. Prof. Foster's essay is in fact a very remarkable one; admirable in style, vigorous and lucid, it gives the reader the impression, which is well founded, that he is being shown the inner history of the growth and development of a great science by one who has the clear vision and unerring judgment of a master of his subject. Hereafter Prof. Foster's article will retain permanent value as the best exposition of the way in which the problems of physiology were regarded, both retrospectively and with a view to future progress, in the latter quarter of the nineteenth century.

Prof. Foster commences by defining physiology as "the study of the actions of living beings on their surroundings and correlatively of the action of the surroundings on the living being," whilst he points out that at an earlier period physiology comprised morphology and corresponded to what is now called biology.

Then follows a sketch of these "actions of a living being." They are brought under three heads:—(1)

Movements; dependent upon the contractions of muscles and the existence of mechanical contrivances connected therewith. (2) *Activity of the Nervous System*; in controlling in various ways and in relation to various external and internal conditions the before-named movements. (3) *Chemical Changes*; these are briefly sketched as not only those directly concerned in the contraction of muscle, but as occurring in all parts of the body. They may be regarded as a slow combustion in which complex substances full of latent energy are reduced to simpler stable conditions with less or with no latent energy. Like St. Paul, the animal, says Dr. Foster, "dies daily." "All the inner labour of the body, both that of the chemical gland-cells, of the vibrating nerve-substance with its accompanying changes of consciousness, and of the beating heart and writhing visceral muscles, is, sooner or later, by friction or otherwise, converted into heat; and it is as heat that the energy evolved in this labour leaves the body." Only as heat or as motion of limbs, jaws, &c., does the energy set free in the animal body make itself externally apparent. This combustion and degradation of material necessitates new supplies, and hence we have the phenomenon of the inception of food and the chemical processes connected with it.

The Problems of Physiology are then stated as the result of the preceding survey of the actions of a living being to be as follows:—(1) To discover the laws of transmutation of complex unstable food into still more complex living flesh, and the laws by which the latter breaks down into waste products, void of energy. (2) To discover the laws of the origin of nervous vibrations, of their passage to and fro in nerve substance and of their ultimate disappearance in connection with muscular contraction or otherwise. (3) To discover the laws of how the energy of chemical action is transmuted into and serves as the supply of that vital energy which appears as movement, feeling, and thought.

This rough analysis of the problems of physiology is "the residue of many successive phases of opinion." It is in tracing the influence of these successive phases and estimating the value of their residues that the skill of Prof. Foster is most successfully exerted. Such an appreciation of the historical significance of the various factors of his science, should, we think, be as much the indispensable possession of a cultivated specialist as is a knowledge of his country's political history to the statesman.

The exigencies of life, Dr. Foster tells us, early directed man's attention to the phenomena of the animal body and thus brought the study of physiology to the front before its time. Hence in the absence of the knowledge of physics and chemistry, explanations were assigned to those phenomena of animal bodies which were not obviously identical with those of inanimate bodies, under the names "vital spirits" and "animal spirits." In the seventeenth and eighteenth century, however, the progress of anatomical knowledge led to the perception of the fact that the animal body contained, if it did not actually consist of, a number of mechanical contrivances each of which could be shown to perform some service in the animal economy for which its construction especially fitted it. In this way grew up the doctrine of "organs" and "functions," and it was held that the inspection of structure was sufficient to enable an acute observer to determine the particular function of any given part. Great progress was made under the influence of this doctrine—the most notable example of its triumph being the discovery by Harvey of the function of the heart and the mechanism of the circulation of the blood. The doctrine of vital and animal spirits still survived as giving an explanation of the motive force which set the complicated machinery of connected organs at work.

In the physiological "cell-theory" of Schleiden and Schwann the adequacy of the doctrine of organs and functions to explain the phenomena of life, whilst apparently finally established, received, according to Dr. Foster, its death-blow. It appears to us that Dr. Foster does not quite give its true significance to "the cell-theory." It is true that the founders of that theory attached undue importance to the structural characters of the cell. But Schwann at any rate attached the greatest importance to the cell-substance, and to its molecular and atomic constitution, and the doctrine that function is dependent on structure, when by structure we understand not merely coarse visible structure, but molecular structure, which differs in any two cases by a difference of internal movement of molecules rather than by a difference of their permanent position—this doctrine is triumphant to-day, and is proclaimed in that portion of the present article which treats of different kinds of protoplasm.

A quotation is given from a well-known article by Prof. Huxley, written thirty years ago, in which it is stated that cells "are no more the producers of the vital phenomena than the shells scattered in orderly lines along the sea-beach are the instruments by which the gravitative force of the moon acts upon the ocean." Apparently Dr. Foster thinks this statement to be defensible even to-day, but the conception of living matter and of the significance of cell-substance and structure thus indicated appears to us to be more difficult to reconcile with the modern doctrine of protoplasm than is the doctrine of Schwann, which, to use his own words, was "le contraire de la théorie generalement admise pour les animaux, d'après laquelle une force commune construit l'animal à la manière d'un architecte," and which argued from the uniform construction of organisms by modification of the nucleated corpuscles called cells that "c'est partout la même force qui reunit les molécules en cellules, et cette force ce ne pouvait plus être que celle des molécules ou des atomes; le phénomène fondamental de la vie devait donc avoir sa raison d'être dans les propriétés des atomes"—that is to say, in the atoms of the substance of which the cells consist which has now received the name protoplasm.

Dr. Foster next gives a vivid picture of the importance of the discovery by Claud Bernard of the glycogenic function of the liver—a function which could not be inferred from the inspection of the liver either macroscopic or microscopic. Such discoveries as these led to the recognition of the existence of most important processes or "functions" in the animal body which had no correlative in visible structure. Thus physiologists were led to see in the mind's eye the invisible structure of cell-substance and the "protoplasm theory" obtained its foundations.

A brief survey of the life of a corpuscle of protoplasm as exemplified in an Amœba follows, and attention is directed to the *constructive* and *destructive metabolism* going on in the substance of such an organism. There are anabolic and katabolic changes in that substance, which may be compared to a double flight of stairs leading up to and down from a hypothetical summit; that summit is what we mean by protoplasm, but whether the term should include a few of the steps up or down or be limited to the top plane cannot at present be decided.

This protoplasm of the unicellular organism exhibits properties which may be classed as (1) *Assimilation;* (2) *Contractility;* (3) *Irritability* or *Sensitiveness.* From the consideration of these we are led on to that of a simple multicellular organism—a Hydra—in which a first stage of differentiation of these properties between two groups of cells—the endoderm and the ectoderm—is observed. Then in due course the further differentiation of these two primary groups of cells in a higher animal is traced—in an account of the organs and tissues with their specialised properties and functions derived by gradual modification from the lower stage of differentiation.

The relation of the complex organs, composed of numberless cell-units, of a higher organism to the practically homogeneous protoplasm of a single cell-corpuscle having thus been traced, Dr. Foster takes one organ of a higher animal—the kidney—as an example of the problems which present themselves to the modern physiologist. There are, he points out, two points of view, two aims of inquiry which pursue in many respects different methods, though ultimately blending and tending conjointly to the explanation of the action of the kidney. They are distinguished as the "mechanical" and the "molecular," and correspond in these later days to the earlier and later standpoints of physiology represented by the doctrine of organs and the doctrine of cell-substance. The physiologist's inquiry is sketched from the first point of view, and it is pointed out that this inquiry "takes on to a large extent the characters of an attempt to unravel an intricate game, in which the counters are nervous impulses, muscular contractions, and elastic reactions, but in which the moves are determined by topographical disturbances and mechanical arrangement." The second kind of physiological inquiry into the kidney ignores for the time being these grosser conditions, and is directed to the molecular action of the protoplasmic cells which build up the distinctive structure of the kidney, namely, its tubules.

Reverting to "a brief survey of the whole field of physiological inquiry," Dr. Foster says:—"The master tissues and organs of the body are the nervous and muscular systems, the latter being, however, merely the instrument to give expression and effect to the motions of the former. All the rest of the body serves simply either in the way of mechanical aids and protection to the several parts of the muscular and nervous systems, or as a complicated machinery to supply these systems with food and oxygen, *i.e.* with blood; and to keep them cleansed from waste matters through all their varied changes."

That, no doubt, is true if the organism be viewed as an individual and not from the point of view which regards the individual as one of a race and the race as part of the general outcome of organic development, and this as again a part of a more general phenomenon. The biologist who takes his stand on the doctrine of evolution must, we venture to think, regard as the "master-tissue" over and above those indicated by Dr. Foster—the reproductive tissue or the specific cells of the ovary and testis. It is in every animal this little nest of germ-plasma handed on from generation to generation with scarcely a change which receives the homage and service of all the various products of differentiation of its brother-cells. The latter are but the carriers, protectors, and servants in the struggle for existence of the undifferentiated germ-plasma—even the cells concerned in thought and reason exist but to protect the germ-cells. The former perish as a mere husk whilst the germ-plasma is immortal; it forms, by growth and fission, on the one hand, new germ-plasma which never dies, and on the other hand protecting tissue-cells, which have only an evanescent existence. As Dr. Foster himself has elsewhere said:—"The animal body is in reality a vehicle for ova, and after the life of the parent has become potentially renewed in the offspring the body remains as a cast-off envelope whose future is but to die."

In the latter part of the article our present knowledge of the nature of protoplasm, and of the processes which go on in connection with it, is forcibly sketched. Different *kinds* of protoplasm are recognised, the differing qualities of which are to be regarded by the biologist as "the expression of internal movements" of the molecules of the protoplasm. The term "mesostate" being used to express those ascending and descending steps of the pyramid whose summit is protoplasm, and "anastate" and "katastate" corresponding respectively with those constituents of cell-substance which are on their way to attain, and those which are falling away from the state of perfect protoplasm, we find that the tendency of inquiries into the molecular processes taking place in living secreting cells, in muscular tissue, and in the various forms of nerve-tissue, "is to lead us to regard the varied activities of these tissues as due to molecular disruptive changes in their several katastates, these being various stages of the downward metabolism or katabolism of protoplasm."

Hering's recent speculations on the relation of colour sensations to the condition of the protoplasm of the percipient cells lead, Dr. Foster thinks, to a new molecular physiology. He gives us the hope that by an application of Hering's conceptions (which the limits of our space do not permit us to notice more fully) to other groups of protoplasmic units a new departure may be effected, and that we may look forward to a very great advance in our knowledge of the nature of the processes taking place in living cells.

Dr. Foster concludes his article with an outline of the methods of physiological inquiry and an unanswerable though brief exposition of the dependence of the progress of physiology upon experiment on living organisms.

The article on Pianoforte is of considerable interest for several reasons; first, because it is signed with the initials of Mr. A. J. Hipkins; secondly, from the number and felicity of the illustrations; thirdly, because it takes up a special and somewhat neglected point in the history and

development of the remarkable instrument which has superseded the far more ancient organ, and which has become the domestic companion and indispensable accessory in thousands upon thousands of households throughout the civilised world.

Probably no man living knows so much about the pianoforte as Mr. Hipkins: attached for many years to the honoured house of Broadwood and Sons; almost able to remember its original title of Tschudi and Broadwood, which carries us back at one bound to the epoch of the harpsichord Mr. Hipkins is not only an experienced musician, but an excellent physicist in his special line. He has read valuable papers before the Royal Society, and efficiently co-operated with Mr. Alex. Ellis in his laborious determinations of pitch and of oriental or archaic musical scales.

The somewhat neglected subject here given with the terseness and accuracy of a monograph, as is proper in a work somewhat of the nature of an index, is the mechanical development of the modern pianoforte from the earliest form of keyed instrument with strings, shown in a drawing by Miss Edith Lloyd of a sculpture in St. Mary's Church, Shrewsbury belonging to the first half of the fifteenth century. Besides this and other woodcuts of typical instruments, is a series of diagrams showing the various forms of "tangent," "jack," "hammer," "action," and "escapement" by which the sounding string has been successively made to vibrate with ever increasing fulness and beauty of tone and quality. Towards the end of the article the recent substitution of metal for wooden framings is similarly summarised and illustrated. No doubt much of this would be hard reading for an unmechanical student; but it was really needed, and as a compact whole could hardly be said to exist previously.

The early part of the article appeals to every reader, and is full of fascinating and original research. There are eleven other capital woodcuts besides that named above of clavichords, clavicymbalums, spinetts, and clavicytheriums, which under a multiplicity of names, preceded the four "gravicembali col piano è forte," which Cristofori, the Paduan harpsichord maker had, on the undoubted authority of the Marchese Scipione Maffei, completed in the year 1709. This date may be looked on as the birthday of the name and the instrument. Originally adjectival and explanatory, it has been adopted substantivally wherever this ubiquitous form of the "dulcimer with keys," as Mr. Hipkins quaintly defines it, has penetrated.

BALL'S "STORY OF THE HEAVENS"

The Story of the Heavens. By Robert Stawell Ball, LL.D., F.R.S., Royal Astronomer of Ireland. (London, Paris, New York, and Melbourne: Cassell and Co., Limited, 1885.)

POPULAR works on astronomy, either on its entire range or selected portions, have been so numerous of recent years as to make it difficult to judge a new one entirely on its own merits; it is felt that there must be some well-marked originality of plan or execution, some novelty of treatment, or freshness of fact, to justify an addition to an already abundant literature.

The present work can urge its claim to a favourable reception on a twofold ground; it is the fullest and most complete exposition of the leading facts and principles of astronomy which has yet been laid before the entirely unscientific public, and it devotes special attention to some of the most recent and interesting astronomical discoveries. It is in no sense whatsoever a student's book, but aims to give, in such simple and untechnical language as may be most acceptable to the general reader, a comprehensive view of the results of astronomy as at present received. So thoroughly is it elementary in character that Dr. Ball from time to time seems to think he has a childish audience before him, and descends to a style which is nowadays considered almost too condescending to be addressed even to children. Thus, in speaking of the distance of the sun, he says (p. 28):—

"The actual distance of the sun from the earth is about 92,700,000 miles; but merely reciting the figures does not give a vivid impression of the real magnitude. 92,700,000 is a very large quantity (*sic*). Try to count it. It would be necessary to count as quickly as possible for three days and three nights before one million was completed; yet this would have to be repeated nearly ninety-three times before we had even counted all the miles between the earth and the sun."

But though Dr. Ball may sometimes resort to this infant-school style he never falls into the opposite fault of being turgid or obscure. His language is always clear and distinct, and when treating of the particular subjects most congenial to him he usually succeeds in avoiding the fault we have just noticed, and his style leaves nothing to be desired.

In a brief introduction Dr. Ball indicates the principal questions which it is the business of the astronomer to seek to answer, and glances at some of the most important discoveries made by the ancients, concluding with the labours of Copernicus. The main volume then commences with a chapter on the astronomical telescope. The Dunsink South equatorial, the great Vienna refractor, and Lord Rosse's 6-foot reflector are described, and illustrations given of them; the Paris meridian circle is represented as a type of meridian instruments, and a well-written page (p. 22) is devoted to drawing a contrast between the ideal instrument and the actual one.

A number of chapters on the different members of the solar system follow. These occupy more than half the volume, and do not call for much special comment, for, whilst travelling over such well-trodden ground, there is but little scope for original treatment. The author throughout gives a clear matter-of-fact account of what he has to describe; there is never for a moment any difficulty in following his meaning, and for a work of this character this is a first essential. The chapter on the Sun is perhaps the least successful. Dr. Ball considers that it is not proved that "sun-spots are really depressions in the surface"; a statement which may be perfectly correct if "proved" is to be taken in its hard mathematical sense; but it ought to be supplemented by the further one that the entire evidence is in favour of that supposition. No reference is made to the frequently-repeated coincidences of solar outbursts and magnetic disturbances which were observed in 1882 and 1883, and which placed the connection of the two orders of phenomena in such a striking light. And again with reference to the spot-cycle, the nature of the cycle is rather crudely stated, and one of its most curious

features—the change of latitude in the *locale* of the spots—is altogether unnoticed. Chapter III., on the Moon, contains a little sketch-map of the moon and descriptions of the most striking formations. The laws of eclipses, the use of the moon in navigation, and Nasmyth and Carpenter's theory of the volcanic origin of the lunar craters are treated of with the author's usual clearness and at considerable length. In the concluding paragraphs Dr. Ball expresses his belief that forms of life unknown to us may probably exist on many of the celestial bodies, and applies to the question of the plurality of worlds the lines of Tennyson :—

> "This truth within thy mind rehearse,
> That in a boundless universe
> Is boundless better, boundless worse."

The fourth chapter deals with the solar system as a whole, with the detection and identification of planets, with the positions and dimensions of their orbits and their own comparative sizes. It is followed by a chapter on the Law of Gravitation, a most important one, and admirably written. The law of gravitation is so important in itself, and so little understood by the unscientific portion of the public, that such an explanation as is here supplied is much needed.

The succeeding chapters deal with the planets one by one, beginning with Vulcan, the "Planet of Romance," which Dr. Ball is inclined to believe was really seen by Prof. Watson during the total solar eclipse of 1878, on the not unreasonable ground that an observer of his experience and skill was not likely to have been mistaken. In the chapters on the other planets the points to which most attention has been paid are the descriptions of the various modes of determining the sun's distance, and the size, form, and weight of the earth. There is a pleasing and somewhat full biography of the elder Herschel in the chapter on Uranus, and the wonderful story of the discovery of Neptune is told again in a fresh and engaging style. Leaving the regular members of the solar system, we come to the comets and shooting-stars, and with these Dr. Ball begins to treat his subject in a somewhat more original manner, and there is very much to commend in these and the following chapters. Encke's comet, the evidence it affords as to a resisting medium, and its usefulness as a means of determining the masses of Jupiter and Mercury and the distance of the Sun, occupy a considerable space. Bredichin's theory of comet's tails is clearly explained. Dr. Ball is, however, scarcely correct in authoritatively classing the great comet of 1843 as a non-periodic one, and the similarity of its orbit to those of the great comets of 1880 and 1882 surely deserved a word of notice. In the chapter on shooting-stars he draws a sharp distinction between meteors and meteorites, and expresses his conviction that Prof. Newton was wrong when he spoke of a meteoric stone as having probably been part of a comet. He also broaches and supports by some ingenious reasoning the idea that meteorites are largely of terrestrial origin, and he points out that meteorites of iron are much less frequent than those of stone.

Chapter XVIII. is on "The Starry Heavens," and is especially commendable for the series of little diagrams in which the relative positions of the principal fixed stars are shown with admirable distinctness. Nothing can be easier than for the reader with this portion of the book in hand to make himself acquainted with the general configuration of the northern constellations. Several instructive points are well brought out in the two following chapters, but in Chapter XXI., on the Distances of the Stars, we find Dr. Ball on ground which he has largely made his own. Herschel's attempt to form a conception of the distribution of the stars in space is clearly explained, and made the basis of a detailed description of the method of determining the distance of a star by its annual parallax, and the cases of 61 Cygni, α Centauri, and Groombridge 1830 are dealt with at considerable length. The difficulties of parallax work are sympathetically described, and the drawback often experienced of a long series of observations failing to show any parallax at all is made the occasion for enlarging on a particular instance of such a failure, viz. Nova Cygni, 1876. The chapter concludes with an explanation of Herschel's discovery of the motion of the solar system towards the constellation Hercules. The spectroscope is much more sparingly dealt with, and the entire range of astronomical spectroscopy is despatched in one of the shortest chapters in the book. It is not possible that so condensed an account should be very thorough or complete, but, given the necessity to confine the subject within these limits, it is difficult to see how it could have been much better done.

The three following chapters deal with Star Clusters, and Nebulæ, Precession and Nutation, and the Aberration of Light. Each of these subjects is well handled; the explanations of the three kinds of apparent motion shown by the stars being clearly and carefully explained, without going into any details which would be likely to prove too abstruse or tedious for any ordinary reader. The chapter on Nebulæ is illustrated by three plates, one of which, Trouvelot's drawing of the Great Nebula in Andromeda, is very well executed.

The two concluding chapters are of especial interest. Chapter XXVI., on "The Astronomical Significance of Heat," deals with the most important points in the history and method of the evolution of the solar system; the presence of heat in the body of the earth, the law of cooling, the heat of the sun and its possible sources, the doctrine of energy, the nebular theory and the evidence which supports it. With respect to this last it should be observed that the old illustration of the trees in the forest is by no means very apposite. Dr. Ball is, however, careful to distinguish such a theory, however magnificent and attractive, from the truths of astronomy properly so called.

From nebular evolution we pass naturally to tidal evolution. It is but comparatively recently that Dr. Ball's lecture upon this subject was reported in these pages, so that it is only necessary to say that the romantic story is well told this second time. The criticisms to which the theory was subjected are not referred to here, though some deserved greater consideration than to be silently passed over.

As we have already said, this is in no sense whatsoever a student's book. Dr. Ball has already shown how well qualified he is to produce such a work when he desires to do so, but he has had an entirely different purpose here. It may be doubted whether he has not in some instances been too general and undefined in his mode of treating

his subject; the explanation of the principles and methods involved in the determination of the sun's distance by means of Transits of Venus, for example, is particularly meagre and unsatisfactory. The public that does not care to have to exert much thought over its reading is not the public that will purchase books on astronomy 550 pages in length; an occasional light article in a magazine will satisfy its utmost craving.

Nevertheless a book which in a lucid and easy style supplies accurate and the latest information as to the methods and discoveries of astronomy, which is written by a competent authority, and which, if not profusely illustrated, is supplied with plates and woodcuts which leave no important object unrepresented, no fundamental argument unsupported, can only be spoken of as a good one; and those who wish to possess a full, interesting, and popular account of the present state of the most noble and enthralling of all the sciences cannot do better than make themselves possessors of the "Story of the Heavens."

OUR BOOK SHELF

Annual Report of the Board of Regents of the Smithsonian Institution for the Year 1883. (Washington: Government Printing Office, 1885.)

THIS is the most bulky, and perhaps the most valuable, of these well-known Reports; it consists of very nearly 1000 pages, and we learn, from the resolution of Congress which precedes it, that 16,060 copies have been printed. The more strictly official part of it deals with the Smithsonian Institution and the Natural History Museum, including the Report of the Committee on the Henry statue recently erected in the grounds; but, besides these, we have Reports on the various branches of science, so valuable that no scientific library should be without them. Astronomy has been taken in hand by Prof. Holden, the newly-appointed Director of the Lick Observatory; meteorology, by Mr. Cleveland Abbe; physics, by Prof. Barker; zoology, by Prof. Guild; and anthropology by Mr. Otis T. Mason, the latter covering nearly 200 pages. Other branches of science besides those which we have named are reported at less length.

When we consider the importance of these *résumés*, and the fact that 7000 copies of the volume are being distributed gratuitously by the Institution all over the world, we may readily concede that in this, as in their other duties, the Regents of the Institution are faithful to the trust imposed upon them by Smithson to promote the increase and diffusion of knowledge among men.

The Sun: a Familiar Description of His Phenomena. By the Rev. Thomas William Webb, M.A., F.R.A.S. (London: Longmans, 1885.)

THIS is a little book of seventy-eight pages, containing what appears to have been a lecture given by the author, who, to the great loss of observational astronomy, died a short time ago. That part of it which deals with the telescopic facts is very much more in harmony with our present knowledge than that smaller part of it which deals with the revelations of the spectroscope. The whole is very charmingly and simply written.

Notes on the Physiological Laboratory of the University of Pennsylvania. By N. A. Randolph, M.D., and S. G. Dixon. (Philadelphia, 1885.)

THIS little volume consists of a series of short papers giving the results of practical investigations into the behaviour of certain substances, such as starch, cod-liver oil, boiled and unboiled milk, &c., when used as articles of food by infants and adults. Many of the papers are of interest; all of them show evidence that in the University of Philadelphia, physiology is not taught as a matter of book-learning, but that the students are instructed in the practical bearings of the science.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Lieutenant Greely on Ice

I HAVE read with deep interest the graphic but brief account of Lieut. Greely's Arctic explorations given in NATURE of November 26 (p. 90), and also in some of the Scottish papers, which touch upon subjects not mentioned in NATURE.

Assuming that these reports are, in all material points, correct, I ask leave to be permitted to offer some remarks on a few of the opinions expressed by the distinguished explorer, the correctness of which seems open to question.

Before doing so, however, I would draw attention to the very considerable difference in the mean yearly temperatures at Discovery Bay, as given by the English Government ship that wintered there in 1875–76, and that of Lieut. Greely wintering at the same place six or seven years later.

Capt. Stephenson, H.M.S. *Discovery*, 1875–76 ...	$-4^{\circ}\cdot23$ F.
Lieut. Greely, in house six or seven years later, about	$+4^{\circ}\cdot00$
Making a difference of	$8^{\circ}\cdot23$

I suppose the thermometers to be in both cases correct, and the mean temperatures computed in the same manner in each case. In saying that "Grinnell Land has the lowest mean temperature in the globe," surely Lieut. Greely goes a little too far, as no observations have elsewhere been made in so high a latitude, nor at any point in the great circle of 1100 miles' diameter *nearer* to the Pole than Discovery Bay, in nearly all parts of which it would be a very natural conclusion to arrive at, that the mean temperature would be lower. Lieut. Greely adds, "This" (the lowest temperature in the globe) "was in accordance with their expectation."

Kane went to the Arctic Sea with "expectation" and a belief that he would find an open Polar sea! His steward, Morton, conveniently found it for him, and it was *believed* in for a time, until other expeditions passed the place where "Morton's pool" of open water had been seen; but alas! not a trace of it could be found, although ships had gone by, creeping along shore, some hundred miles further north. The distinguished Greenland explorer Rink, finally, effectually demolished this Arctic dream. Lieut. Greely's open Polar sea of 1100 miles' diameter round the Pole seems to be a myth of a somewhat similar kind. It is purely a theory, with facts, to my mind, adverse to its probability; for why this immense body of water in the far north, whilst constantly sending forth great ice-streams southward through the broad inter-Greenland-Spitzbergen Channel, should be itself ice-free, whilst other seas far southward, having a much higher temperature, and probably with currents and gales of wind at least as strong, are ice-encumbered, is rather difficult to understand.

As regards floebergs, Lieut. Greely has advanced their size and thickness far beyond anything one would infer from reading the narrations of the English Expedition of 1875–76, which first gave the name to those curious masses of ice. He has not only done this, but he attributes their formation to a source which completely destroys the meaning of the name "floeberg," used in contradistinction to "iceberg," to show that the former has its origin from the floe or sea ice, instead of from ice formed on land, and is either built up by the gradual increment of the floe and the snow that falls upon it, or, as I believe more likely, by a number of floes being forced by immense pressure one over the other, until great thickness is attained. Perhaps the best example of a floeberg (according to my idea) that I can give, is that which lifted the ship of the Austrian Expedition seventeen feet (I think) out of

the water, became a great floating mass of ice in a week or less, a mile in extent and of great thickness, and carried those good explorers Weyprecht and Peyer helplessly about for a long time in 1873-74, in Barentz Sea, then landed them safe on one of the Francis Joseph Islands; thus leading to the discovery of this great Northern land. Snowdrifts would in the course of one winter (I have seen a fifteen feet depth of drift in one night) fill up most of the inequalities of surface, and thus the floeberg is complete.

Lieut. Greely says that these "floebergs are simply detachments from slowly-moving glacial ice-caps, from an ice-covered land in the neighbourhood of the Pole;" that "Dr. Moss (of the *Alert*) was certainly correct as to the universality of stratification in this *ancient* ice, and he concurred in the Doctor's opinion, that its salinity was due to efflorescence and infiltration."[1]

First as to the formation of these floebergs; Lieut. Greely tells us they are detached from an ice-cap 1000 to 4000 feet thick near the Poles. Surely if this were so, some of these great masses, which would show about 140 feet above water, would have been seen by Parry, when in the summer of 1827 he was in lat. 82° 45′ N. (only thirty-nine miles south of Greely's extreme) to the north of Spitzbergen; but neither Parry nor any of the brave whaling captains, who have gone to high latitudes between Greenland and Spitzbergen—the great highway of northern ice in its southward drift—have ever seen anything of the kind.

In the Antarctic we all know that such ice-mountains (the source of which Sir James Ross's discoveries tell us of) drive down to lat. 60° S. near to Cape Horn; the natural idea is, that they would do the same thing in the Arctic Sea—in company with the great ice pack, through the wide high road above mentioned—and not confine themselves to the coast seen by Lieut. Greely's party.

A word or two on my own experience much further to the south. When passing in my boats for 800 or 900 miles along the west shores of Hudson's Bay in 1846 and 1853, I saw several floebergs aground, some thirty or forty feet above the surface, so large and high that any one at a distance of a mile or so, would have mistaken them for true icebergs; they were merely a mass of floes forced together by strong winds. In such low latitudes (58° to 66°) these spurious icebergs all disappeared before autumn.

No true iceberg that breaks away from land-ice is ever found, as far as I know, to contain saline strata, as the late Dr. Moss found to be the case with the floeberg from which the crew of the *Alert* in 1875-76 took the ice, for drinking or making tea. Sometimes this ice was so salt as to be unfit for the purpose, although high above the sea-level. This result is attributed by both Dr. Moss and Lieut. Greely to "infiltration." I cannot understand how saline fluid could "infiltrate" *upwards* from the sea into ice—a solid—in which there would be no pores through which it could flow, apart from the fact of the greater specific gravity of the brine.

I do, however, know from personal experience that saline fluid does, under certain circumstances, percolate or filtrate *downwards*, converting sea-ice, previously saline, into a sufficiently fresh state to afford good drinking-water when thawed. This discovery, like a good many others of more importance, was accidental. In passing a piece of old ice—that is, of a former year's formation, which was known to be so by its wasted and rugged outline, as it stood some feet above the surrounding level ice-floe—I knocked a small piece off, and on putting it into my mouth, found it quite fresh. From that time, during sledge journeys of 1200 miles in the spring of 1847, I looked out for some old rough ice, before building our snow-hut for the night's shelter, so as to get water quickly.

Experience had taught me that a kettleful of water could be obtained much more rapidly and at a far less waste of fuel by thawing ice than from snow, because the latter, however closely packed, contained much air, which, at a temperature of zero or lower, required extra fuel to warm it *up* to 32° Fahrenheit; a kettleful of snow will give little more than a third of a kettleful of water, whilst the same measure of ice will nearly fill the kettle with water.

The fresh ice I speak of could not be part of an iceberg, because there were no bergs in the great bay where we were travelling. Moreover, if a piece of this ice (which was fresh at a few feet above the sea-line) was chopped off on a level with or below the water-line, it was found to be saline.

How does this take place? Simply, I imagine, by the brine or saline fluid filtrating downwards through pores made by itself in the ice, as soon as the summer temperature became high enough to thaw the saline part, the fresh portion retaining its solidity, with the exception of the minute pores worn out as above described.

My belief is that the floebergs seen, and so named by the English Expedition of 1875-76, were formed of saline sea-ice, piled one floe over another, and that when the summer temperature penetrated them to a certain extent, the salinity filtered downwards as above described, but that certain layers or strata, either from not being subjected to a sufficient rise of temperature or from some other cause, still retained their saltness.

All sea-ice has a surface-layer, more or less thick, of brine efflorescence, far more saline than the body of the floe. If, then, six or eight floes are forced up, the one over the other, there will be so many layers of these thin very saline strata.

I repeat that infiltration *upwards* in this case is contrary to all aws of gravitation, unless those learned in chemistry or physics can show that there is some powerful attraction or affinity to drag a saline fluid upwards through a dense solid.

This communication has gone far beyond the limits I intended, and yet is very short of what might be said on other parts of Lieut. Greely's lectures in Scotland. I must conclude by expressing my admiration of the great amount of geographical work done by this expedition, and the miraculous rescue of the few survivors where twenty-four hours' delay would have been fatal, resembling in this respect very closely the rescue of a *part* of a Government overland expedition in Arctic America sixty-four years years ago, who, but for the arrival of friendly Indians with food and most tender nursing of them, could not have lived more than a couple of days longer.

4, Addison Gardens, Kensington, Nov. 28 JOHN RAE

P.S.—The *Scottish Geographical Magazine* has just reached me, by which I find Greely's mean temperature of his winter quarters to be −4° F. instead of +4°, therefore almost exactly the same as the temperature found by the English Expedition of 1875-76, instead of there being 8° difference—as I put it.—J. R.
December 7

[1] I met the late Dr. Moss at the British Association when held some years ago in Dublin. We conversed a good deal on the above subject. I learnt from him, if my memory is correct, that the floeberg from which the crew of the *Alert* took the ice to thaw for their use, was found to have strata too saline to drink. This explanation I think requisite.—J. RAE.

The Recent Star-Shower

IT being important to ascertain the duration of the recent shower of Andromedes, observations were continued here on the night of November 30. During a watch maintained for about four hours and a half between 5h. 30m. and 10h. 15m., ten Andromedes of most certain character, together with two other meteors, in reference to which some doubt existed as to their absolute identity with this stream, were recorded from a radiant-point carefully determined at $21° + 42\frac{1}{2}°$. Thirty-one non-conformable shooting-stars were also seen from showers in Perseus and the region eastward.

It is therefore clear, from the results obtained on November 30, that the display had not lost its visible character, though it had evidently subsided into a state of great feebleness. It yielded certainly not more than three meteors per hour for one observer, and these were extremely faint.

On the evening of December 1 the sky was again clear. A prolonged watch of the region of Andromeda then revealed no trace of the display. Meteors were very rare, generally, all the evening. On December 4 they were very frequent, but the radiant-point near γ Andromedæ gave no sign. The ζ Taurids and Geminids (which are specially mentioned in the current number of NATURE (p. 108) as deserving observation during the present week) were both visible, and a number of contemporary streams had come actively into play. But, during long watches on the nights of December 1 and 4, there was no appearance of outlying Andromedes. The cessation of the shower definitely occurred between November 30, 10h. 15m., and December 1, 5h. 45m., after an *observed* duration of little more than five days. But this period unquestionably fails to represent the real duration, for, could observations have been made before moonrise on the early evenings of November 24 and 25, there is no doubt it would have been detected. We can hardly admit a sudden rise of the shower from invisibility on the 25th to a degree of richness on the 26th sufficient to give more than 100 meteors per hour. It is to be hoped that reports from other stations will throw some light on the visible development of this remarkable stream. In any case the extremely narrow limits of its display

on November 27, 1872, offers a strong contrast to the comparatively prolonged duration observed at its recent return.

Bristol, December 6 W. F. DENNING

WHILE watching the meteor shower of the 27th ult. I observed what closely resembled the appearance of an aurora. There was seen extending along the horizon from about south to about west-north-west—perhaps further towards the north, for my view was there obstructed—and upwards for about 20° from the horizon, a faint reddish-pink luminous haze, varying fitfully in colour, becoming sometimes nearly white, and in intensity both as regards time and position. The greatest brightness noticed by me was nearly due south. Stars were clearly visible through it.

On referring to the letters in NATURE upon the shower of November 27, 1872—to refresh my memory upon other points—I found that appearances of an aurora on that evening are recorded by "several correspondents." [Mr. Denning's letter in NATURE, December 5, by Father Denza in Piedmont (NATURE, December 19), by Mr. Baber at Liverpool (same number), and the Hon. Mr. Newton and Mr. Bruce at Mauritius ("a pulsating coruscation, similar to the appearance of the aurora australis"), NATURE, January 23, 1873]. NATURE for January 16, 1873, contains a letter recording a "pale auroral light" seen at the same time as a shower on December 7, 1838, and Mr. Denning (April 24, 1873), records that the April shower was accompanied by "bright displays of auroræ."

Mr. Newton and Mr. Bruce add that "the instruments at the Observatory gave no indication of a magnetic disturbance."

Some of your readers may be able to say whether any magnetic disturbance was observed on the evening of the 27th ult. I saw the auroral appearance about 7.15 p.m.

Rugby, December 7 J. B. HASLAM

P.S.—In a note received to-day in answer to my inquiry, the Superintendent of the Kew Observatory kindly informs me that at Kew the "magnetic curves for horizontal intensity, vertical intensity, and declination were remarkably steady throughout the whole of the 27th and 28th ult., being almost straight lines at the time of the meteoric shower." He adds that no auroral effects were seen at Kew.—J. B. H. (Dec. 8.)

IN case England has been clouded on the 27th, it may be well to state that the meteors were brilliantly seen in the Adriatic. A few were visible on the night of the 26th; on the 27th, at 16h 30m. G.M.T., they averaged thirty per minute; at 17h. they had much increased, and were counted, at 18h. 10m., at seventy per minute, while at 20h. 40m. they had decreased to thirty per minute again; on the 28th very few were seen. During the rapid shower they were not equally distributed; for six or eight seconds only one or two were to be seen, and then, in a couple of seconds, perhaps eight would be counted, mostly seen simultaneously. The radiant-point was estimated at about 15° S. of the following end of Cassiopeia at 16h. 30m., and at about 3° S. of the preceding end at 20h. 40m. The trails were more persistent and brilliant in the latter part of the evening. One was distinctly seen by two observers to sharply bend its apparent course about 20°, possibly a case of perturbation by a non-luminous meteor, or else of splitting. A large number were as bright as first-magnitude stars, and many equal to Venus. WM. F. PETRIE

s.s. *Tanjore*, November 28

FROM the accounts in NATURE and in the *Times*, it is evident that the display of meteors was much finer in the east of Switzerland than any of those mentioned by your correspondents. My attention was first directed to the shooting-stars shortly after 6 o'clock (local time here being about thirty-eight minutes in advance of Greenwich time). For half an hour after that time the fall was continuous, several meteors appearing together. In fact, so many were falling, that it seemed to me hopeless to attempt to count them, but I should think that they must have fallen, on a moderate computation at that time, at the rate of at least 200 a minute. Many of them were especially brilliant, and those falling near the mountains, which completely encircle this village, produced, I presume by irradiation, the curious appearance of passing between the spectator and the mountains. The richest period of the display when, looking from a window, four or five were seen together in one part of the heavens did not last for more than an hour, but the phenomenon continued with less effect until 9 o'clock, when the sky which, until that time had been perfectly clear, became overcast. The height of the high-lying plateau of the Canton Grisons, more especially in the Engadine, and the remarkable absence of aqueous vapour, causes many more stars to be visible here than in the denser air of England, and this, no doubt, in large measure, accounts for the superior brilliancy of the display as witnessed here. This strangely affected the imagination of some of the peasants of this village, one young woman in particular spent the evening in tears and lamentations, momentarily expecting the end of all things. J. F. MAIN

Wiesen, Canton Grisons, Switzerland

"Evolution without Natural Selection"

TWO or three points in Mr. Romanes's letter in your issue of December 3 (p. 100), leave me no other alternative than to again ask you to insert the following few remarks. I beg to inform Mr. Romanes that with Darwinism my book has very little to do. It neither attempts to refute nor confirm the Darwinian hypothesis of Natural Selection. Neither is it an "emendation of Darwinism"; but the facts it contains seem to be an all-necessary supplement to the great naturalist's hypothesis. It is to be regretted that at the present time so many naturalists accept the theory of natural selection as an exclusive explanation of the evolution of existing species. They unconsciously blind themselves to the existence of any other agent in the work of evolution. To them there can be, nor is, no other. No greater error could be made; and it is my firm conviction that as time goes on the theory of natural selection will gradually lose much of its present presumed universality. What is becoming more evident every day is that existing species do not owe near so much to natural selection for their evolution as extreme Darwinians would have us believe. What the remote ancestors of these species derived from its influence is another matter. How far its influence has been exerted on living forms is not for me even to conjecture; but certainly, so far as birds are concerned, the evidence of its influence is astoundingly slight in comparison with the number of species.

I am very pleased to see that Mr. Romanes has changed his opinion concerning "trivial specific characters," and now admits that they are both numerous and important. But they cannot even be regarded as "insignificant" as compared with the great "organising work of natural selection." For, according to the Darwinian theory, they should owe their very presence to its influence, but, unfortunately for the hypothesis, they do not. Once more I must strongly protest against Mr. Romanes saying that my book attempted to explain the *cause* of variation. It does nothing of the kind. Nor do I consider it fair for Mr. Romanes to infer that isolation, &c., do not explain the cause of variation, and therefore that they fail as evolutionistic agents. It would be just as fair and logical to say that the Darwinian hypothesis is a failure because it does not explain the cause of variation. Darwin must have a variation to begin with for natural selection to work upon; so must isolation. The cause of variation is one of the greatest secrets which Nature still retains in her keeping; but doubtless it will soon be wrested from her.

London, December 6 CHARLES DIXON

I HAVE not changed any of my views; but Mr. Dixon appears to change his within the limits of two consecutive sentences. For, immediately after his strong protest against my statement that he has attempted to explain the causes of variation, he complains of my want of fairness in not acknowledging the adequacy of the "evolutionistic agents" which he has suggested as "the causes of variation." With this specimen of Mr. Dixon's method of discussion before them, your readers may be able to sympathise with the failure which seems to have attended my efforts at expounding his essay.

The analogy between isolation and natural selection does not hold. For is it not obvious that while natural selection can be understood to operate in an explicable manner on the variations supplied to it, there is no analogous explanation to be given of the manner in which isolation can so operate—*i.e.* why isolation *per se* should preserve some of the variations and not others? That isolation is a favourable *condition* to the occurrence of trivial or non-adaptive specific change, I have not denied; but, on the contrary, expressly affirmed: I have only denied that it can be regarded as the *cause* of such change—and least of all in any way similar to that in which natural selection may be re-

garded as the cause of important or adaptive specific change. Therefore, if it is the case that "so many naturalists accept the theory of natural selection as an exclusive explanation of the evolution of existing species," I think that Mr. Dixon has done well to correct their error. Only I am not aware that any naturalist of note has allowed his belief in Darwinism thus to go beyond the teaching of Darwin.

GEORGE J. ROMANES

Scandinavian Ice-Flows

FAILING any more direct answer to Sir J. D. Hooker's query (NATURE, vol. xxxiii. p. 79), perhaps, with your usual courtesy, you will allow me space for one or two brief notes. The map referred to, as it stands in "Climate and Time," p. 449, is conjectural to a very large extent. If we are to take the relative closeness of the lines to indicate comparative depth and strength of the glacier-flow, the Baltic must have been, at the intensest period of glaciation, a glacier-filled valley, on an enormous scale, with the ice-stream passing out over the comparatively low, and then submerged, country of Schleswig-Holstein. Dr. Croll, to support a foregone conclusion, represents it thus, and then makes it bifurcate conjecturally about the Dogger Bank. One or two considerations, however, make Dr. Croll's conclusion less "inevitable" than he seems to imagine (p. 449).

(1) Admitting, as we must, that the striations mentioned (p. 448) on the Island of Bornholm, point to the passage of ice in massive proportions over at least that island in the *direction* indicated by the lines on the map, we may still call in question the hypothesis which regards the *main mass of the Baltic ice* as having passed that way.

For (2) the evidence given (p. 449) of its having passed over Denmark (the bare "fact that the surface of the country is strewn with debris derived from the Scandinavian peninsula") is so ambiguous as to be worthless on the point under consideration.

(3) The *facts* stated by Dr. Croll (stripped of the guise with which he has invested them) can be easily and naturally accounted for by the action of *marine* ice, owing its origin to the great Scandinavian glaciers of the period; some of which, even from the Baltic side, probably drifted away into the present North Sea basin.

But (4) that *the main mass* of the ice from the *eastern* slopes of the great glaciated Scandinavian range did not take this direction is proved by some of the best-established facts of European geology; facts which, had they been known to Dr. Croll, would have rendered, I venture to think, the construction by him of the map referred to impossible. On p. 447 he says, "After passing down the Baltic, a portion of the ice would probably move south into the flat plains in the north of Germany, but the *greater portion* would keep in the bed of the Baltic, and of course (*sic*) turn to the right round the south end of Gothland, and then cross over Denmark into the North Sea."

The *naïveté* of this statement, in a book bearing date 1875, is truly refreshing. Any one who knows the district of Jena is perfectly familiar with the enormous abundance of ice-transported material from Scandinavia to be found thereabouts; and these "Findlinge" are spread far and wide over the whole North-German plain as far inland as Bonn, Westphalia, Thüringen, Saxony (even to the south of Zwickau), and, according to Credner's later observations (*Sitzber. der naturforsch. Gesell-schaft*, Leipzig, 1875), into the interior of Bohemia, as far as Troppau, near the sources of the Oder, on the slopes of the Sudeten Gebirge, and even to Toula and Moscow.

(5) Lastly, the occurrence of striated blocks of Scandinavian origin in the boulder-clays of the Yorkshire coast, is clearly incompatible with the conjectural view so graphically expressed on the map in question.

A. IRVING

Wellington College, November 30

The Resting Position of the Oyster

I FEEL some disinclination to take up more space in the pages of NATURE on this subject without making any new contribution to the discussion, but Mr. John A. Ryder's letter induces me to summarise the facts which have been brought forward, and the conclusions to be drawn from them. The condition of the oysters examined by me can only be explained by inferring that they were quite free, and resting on a flat bottom with the right valve downwards. The specimens of *Pecten opercularis* which I had before me were in the same condition, and doubtless rested in the same position. Of *Pecten maximus* I cannot speak with certainty, and therefore leave to Mr. Arthur Hunt the responsibility of stating that there is a difference in respect of position in the two species. Prof. Möbius also finds, that the left valves of oysters are usually covered by fixed animals, but as far as I understand his letter he thinks this does not prove that the left valves in this condition were uppermost: in the oysters I examined, the right valves were so clean that they must have been in close contact with the bottom. The other letters on the subject all describe evidence proving that oyster larvæ attach themselves by the left valve. This I did not deny, and I might of course easily have found the direct testimony of observers on the subject. Mr. Ryder says it is well known that the right valve of the oyster is always the most deeply pigmented, while the left one is paler; in the oysters I examined, the condition of the valves was exactly the reverse of this. It seems to me that when a young oyster is attached to the under-surface of a stone or shell by its left valve its right valve is lower, and if it drops from its attachment, or grows much larger than the stone or shell to which it is fixed, the surface of its right valve will come into close contact with the sea-bottom. I have seen oysters which still retained a piece of shell attached near the umbo of the left valve, while the rest of the valve was covered with fixed animals, and the right valve was quite clean and light in colour. There are no crowded oyster-banks in the Firth of Forth, and it might even be said that the oysters which came under my observation had been dredged and thrown overboard again at some time of their lives. But I do not think oysters are often returned to the water when once taken in the Firth. In my former letter I implied that probably in the normal position of an adult oyster the right valve was in contact with the bottom. That this is often the case when the oyster is free and has plenty of room has not yet been disproved, and therefore I think the current statement that the oyster, when not attached, invariably rests with its left valve downwards needs modification.

J. T. CUNNINGHAM

Scottish Marine Station, November 28

The Sea-Mills at Argostoli

I WILL be glad if, through the columns of your journal, you will be good enough to inform me what has been written in English concerning the phenomenon known as "The Sea-Mills at Argostoli." Having recently visited the island of Cephalonia I was able to examine these mills frequently, and I have reasons for believing that papers have been read at different times at some of the learned societies at home discussing the subject *in extenso*. I will therefore be glad of *any* intelligence on this interesting phenomenon which you may be able to refer me to.

J. LLOYD THOMAS

H.M.S. *Téméraire*, Mediterranean, November 15

Earthquake

ON Thursday morning, December 3, I was in bed awake, between 6 and 7 o'clock. I heard a slight clattering noise of the earthenware and glass articles on the marble top of the washstand. It lasted for about three seconds, and went .... with a slight halt near the end. There was no one moving in the house, and nothing outside to cause the tremors, which I did not feel in bed. I immediately got up to look at the clock, and found it was 6.45. I do not know at what time the earthquake in Algeria took place, possibly there was some connection between the two, and the tremor may have been felt in other places in England, so I record this.

Gateshead, December 6

R. S. NEWALL

VENTILATION

IN modern life, with its enormous populations living under artificial conditions in towns and cities, the subject of ventilation, or the supply of sufficient pure air to each individual for the maintenance of health, has assumed, as it has become more generally understood, a vast and national importance. Its importance has been clearly demonstrated in many instances by a greatly diminished death-rate in places where overcrowding on space or in houses, formerly existent, has been remedied

and especially by a decrease in those diseases which are now generally recognised as preventible. Thus, since attention has been paid to the amount of cubic space and the supply of fresh air per head in barracks, the death-rate from phthisis or destructive diseases of the lungs in the army has fallen from 10 to 2 per 1000; and typhus, formerly very prevalent in the gaols of the country and in the crowded courts of our large cities, is now almost unknown in these situations. That there is still a vast amount of disease and death which could be prevented by a more general recognition of the absolute importance of a pure supply of fresh air under all conditions, is a fact whose truth we recognise when we observe the numbers of scrofulous and ricketty children and consumptive adults in our large centres of population. Many houses in the poorer parts of towns are absolutely debarred from obtaining fresh air and light by their surroundings. Built almost back to back, or fronting into narrow courts or passages closed at one or both ends, the sunlight never penetrates for months in the year, and a free current of air is an impossibility. Fortunately the Legislature has recognised this evil, and the Acts known as Sir Richard Cross's and Torrens's are intended to remedy such a state of things, and, where enforced, have succeeded in removing buildings which no structural alterations could improve. The erection of huge blocks of Industrial Dwellings, whilst affording vastly superior accommodation to the working classes, has not always secured efficient ventilation in these respects for certain of the tenements. We have seen instances of lofty blocks being built in such a way as to enclose a narrow and well-like court, in which the atmosphere is always stagnant, and from which the inner rooms derive all their light and air. Cottage buildings, with sufficient space in front and rear, are far preferable to lofty blocks placed in rows; but as they do not house the same number of people for the space occupied in crowded districts, where land is of such enormous value, the rents must necessarily be higher, the other accommodation being the same. The air of enclosed courts is often damp, and being stagnant allows suspended particles to fall and foul gases to accumulate in it, thus forming a suitable "nidus" for the growth and cultivation of such disease germs as are capable of existing in the air. It is true that the death-rates appearing in the reports of many of the Industrial Dwellings Companies' are exceptionally low, but we must remember that a very large proportion of the working clases die in hospitals and not in their own houses, and such sources of error require to be very carefully eliminated. Of late years Artizans' Dwellings have been built on better principles, the experience derived from the sanitary failures of certain of the earlier erections having been taken to heart.

In the model bye-laws of the Local Government Board it is provided that no new street is to be less than 36 feet in width, that the frontage of any new building not standing in a street shall be at least 24 feet in width, and that there shall be an open space at the rear of any new building and belonging to it of an aggregate extent of 150 square feet, this space not to be in any case less than 10 feet wide, and if the height of the building exceed 35 feet, to be not less than 25 feet wide. If these rules could be always enforced in the cases of new buildings an improvement would be gradually effected in and around towns in the poorer districts which is greatly needed.

From what has been said it will be seen that one of the principal points in any system of ventilation is that the air to be admitted into a building should be pure, and this can be ensured if there is no impediment to the free circulation of currents of air on the outside. We come now to the second part of the subject, viz. the vitiation of air that is constantly going on in inhabited places from the respiration of men and animals, and from the combustion of gas, lamps, and candles, and the methods by which this vitiated air may be replaced by pure external air. The composition of the atmosphere is as follows in 1000 parts: nitrogen, 790·0; oxygen, 209·6; carbonic acid gas, ·4, and traces of ozone, ammonia with nitrous and sulphurous acids in the air of towns, and a variable amount of aqueous vapour. The air taken into the lungs of a human being has this composition, but that expired differs from it in the following particulars, the nitrogen remaining the same: the oxygen which is the vital principle of air is diminished 4 per cent., the carbonic acid is increased 4 per cent., the expired air is saturated with aqueous vapour and is heated nearly to the temperature of the body, 98° Fahr., and contains a small proportion of foul, decomposing organic matter, which exists partly in the form of vapour and partly as solid suspended matter (epithelial dust and scales). This organic matter, though small in amount, is the most injurious quality of expired air, giving to the atmosphere of an ill-ventilated room its close and disagreeable smell. Those who are familiar with the interiors of courts of law, with the pits and galleries of theatres, or with crowded buildings generally, are also familiar with the headaches, the lassitude, and the "malaise" produced by breathing for some hours a vitiated atmosphere. In analyses of such air nearly ten times more carbonic acid has been found than is normally present in the outer air, and when this excess is known to mean a deficiency in oxygen and a corresponding excess in organic vaporous exhalations and suspended matter from the breath and bodies of the persons present, the foul nature of the atmosphere can be realised. The slow deterioration in health, which results from the constant breathing of foul air, is one of its most important results, and causes a predisposition to, and lessened power of, resistance to attacks of disease.

An adult man of average size takes in and breathes out, when at rest, about 30 cubic inches of air at each respiration, this act being performed about seventeen times in a minute, so that in one hour about 17 cubic feet of fresh air will have been vitiated to the extent of containing 4 per cent. of carbonic acid—that is to say, about ·7 cubic foot. Such a man gives out when at rest, therefore, nearly ·7 cubic foot carbonic acid gas per hour. Now it has been found by Dr. De Chaumont, by chemical examination of a large number of samples of the air of inhabited rooms, that the amount of carbonic acid in the outer air being ·4 per 1000, no close smell is perceived in the air of a room until the carbonic acid reaches ·6 per 1000, or exceeds by ·2 per 1000 that in the outer air, the close smell being always due to the foul organic matter in the impure air, which increases *pari passu* with, and is therefore estimated by the amount of carbonic acid present. It has been assumed by De Chaumont, and experience has fully confirmed this assumption, that we can breathe with immunity air vitiated to this slight extent, but that we should not allow any greater vitiation. We may take it, therefore, that the object of ventilation is to supply sufficient pure air to a room to prevent the carbonic acid rising above ·6 per 1000, this quantity being known as the limit of respiratory impurity. It may be asked why should not the air of our rooms be as pure as the air outside? No doubt this would be desirable, were it not that it involves a continual renewal of the inner air by the outer, which means in cold weather an unceasing draught at an unbearable temperature. We have seen that an ordinary adult man expires ·7 cubic foot of carbonic acid in one hour when at rest, now if such an individual were enclosed in an airtight chamber, 10 feet high, 10 feet wide, and 10 feet long—that is to say, in a chamber containing 1000 cubic feet space—in one hour the carbonic acid in this chamber would have had added to it ·7 cubic foot of carbonic acid; the air originally contained ·4 parts of carbonic acid in 1000 parts, so that after one hour it would contain $·4 + ·7 = 1·1$ parts of carbonic acid per 1000, or $1·1 - ·6 = ·5$ parts per 1000 above the permissible limit for health. But if the subject of our experiment were enclosed in a room containing 3500

cubic feet of space, in one hour the amount of carbonic acid would be only $\frac{3.5 \times .4 + .7}{3.5} = .6$ per 1000, *i.e.* the limit would have just been reached, and at the end of a second hour, to keep the carbonic acid to this limit, another 3,500 cubic feet of fresh air must have been allowed to enter the room. That is to say, an adult man requires when at rest 3500 cubic feet of fresh air per hour; a woman or child requires proportionally less. For any individual above twelve years of age, we may take as an average the amount of carbonic acid expired per hour as ·6 cubic foot, and for such an average individual 3000 cubic feet of fresh air per hour is necessary. We can now appreciate the importance of cubic space, for if we are to supply 3000 cubic feet of fresh air to every individual above twelve years in a room, and the amount of space, suppose, in a dormitory where ten persons sleep is only 300 cubic feet per head, then 30,000 cubic feet of fresh air must be supplied per hour—that is to say, the air of the dormitory must be completely changed ten times in this period, a proceeding which would cause in any but the very warmest weather a very disagreeable draught. But if the cubic space per head be 1000 feet, then the air of the dormitory need be changed only three times per hour, and if such renewal be effected steadily and gradually no draught need be felt. We may mention here that a certain amount of superficial or floor space is necessary for each individual, for if the height of the room is much over 12 feet, excess in this direction does not compensate for deficiency in the other dimensions, although the cubic space may be the same; thus it would not be the same thing to allow a man 50 square feet of floor space in a room 20 feet high, as to allow him 100 square feet of floor space in a room 10 feet high, although the amount of space allotted to him in each case would be the same. It may be interesting here to mention that in common lodging houses under police regulations, 240 cubic feet of space are allotted to each adult, in barracks about 600 cubic feet, in general hospitals about 1000 cubic feet as a rule, and in infectious fever hospitals from 1500 to 3500 cubic feet—in these latter institutions the floor space allowed per bed is from 150 to 300 square feet. From the report of the royal commission on the housing of the working classes it would appear that even the low allowance of the common lodging houses is very often not attained in the crowded rooms of tenement houses, and an enormous number of cellars are still inhabited in our large towns, although they presumably come up to the requirements of the Public Health Acts as regards their ventilation.

Gas, candles, and lamps use up oxygen and produce carbonic acid and water. A cubic foot of coal gas produces, when burnt, 2 cubic feet of carbonic acid, and since a common burner consumes 3 cubic feet of gas in an hour, it produces 6 cubic feet of carbonic acid in the same period. Therefore, as much air should be supplied to dilute the products of its combustion as would be necessary for three or four men. It is far better, however, to use such gas-lamps as are shut off from the air of the room. These receive the air necessary for combustion from without, and the products of combustion are carried off by a special channel to the outer air. The electric light uses none of the oxygen of the air and gives off no carbonic acid nor water, and is for these reasons far preferable to naked flames for lighting purposes.

Ventilation is said to be carried on by natural or by artificial means. In the former are included (1) diffusion of gases; (2) action of the wind by perflation and aspiration; (3) movements caused by differences in weight of masses of air at different temperatures. By the latter, although the same principles are involved, is meant exhaustion of air by heat or by steam from apartments, or propulsion of air into such spaces by mechanical means, as fans. Diffusion causes a rapid mixing of different gases placed in contiguity; thus the gaseous impurities of respired air mix with the fresh air in a room until homogeneity is established. Diffusion, however, does not affect the suspended matters which tend to fall in a still atmosphere. Consequently organic matters which exist principally as minute solids in a state of suspension in the air, are not affected or removed by diffusion. The wind when in motion causes a partial vacuum in the interior of tubes, such as chimneys and ventilating shafts placed at right angles to its course. The air in these tubes being thus partially aspirated or sucked out by the action of the wind, to restore the temporary vacuum so made, air from below rushes up to take its place, a continual current in a perpendicular direction being thus set up. Perflation by winds is the setting in motion of masses of air by the impact of other masses. This action is illustrated when the windows on opposite sides of the room are fully open. The room is rapidly and continually flushed with air, an enormous effect being produced, for it has been estimated that the air of such a room may be renewed many hundred times an hour, even when the movement of air outside is only 2 miles an hour or $1\frac{1}{2}$ feet per second, equivalent to a very gentle and almost imperceptible breeze. Such a method is of unquestionable utility for rapidly changing the air of an unoccupied room, and may be generally put in operation in summer in inhabited rooms when the temperatures outside and inside the house approximate. In any system of ventilation that depends entirely on the wind there is always the difficulty of regulating the velocity of the current according to the amount of movement of the air, and during complete calms the action is nil. For ventilating the holds and interiors of ships at sea, the wind may be most advantageously utilised. A cowl placed so as to face to the wind conducts the air below, whilst another reversed so as to back to the wind allows the used air to escape.

The movement due to masses of air at different temperatures is the natural force chiefly relied on for ventilating the interior of houses. The air of inhabited rooms in this climate, except in warm summer weather, is at a higher temperature than the outer air; hot air is lighter than cold air, and will rise for cold air to take its place—in fact, heated air is displaced upwards by colder and denser air. In a room as usually constructed with sash windows, with a fire-place and chimney, but without any special means of ventilation, when a fire is burning in the grate the heated air of the room in part ascends the chimney-flue, and in part rises to the ceiling. Cold air from outside will then enter, if the windows be closed, under the door, under the skirting boards, between the sashes of the window, and through any other chinks or apertures due to loose fittings. The bricks and plaster of the walls are also porous to a slight extent, and if not covered with paint or wall paper will admit air to a limited extent. Thus a large volume of air may be entering a room in cold weather when the fire is burning although there be no visible inlets, and the amount of air thus supplied may be sufficient for the needs of two or three persons if it were properly distributed. But such is not the case. The cold air, which enters chiefly near the floor, takes as straight a course as possible to the fire-place, producing a disagreeable draught to the feet of the occupants, whilst the heated and vitiated air near the ceiling is left undisturbed. It has been found practically that to prevent draughts, and to ensure a thorough distribution, fresh air should be admitted into a room above the heads of the occupants, an upward direction being given to it, so that it may impinge on the ceiling, mix with, and be warmed by, the heated air in this situation, fall gently into all parts of the room, and be gradually removed by means of the chimney-flue or any other outlet. The inlet openings for fresh air now most in use are intended to serve this purpose. For sash windows Hinckes Bird's method, now so well known, of placing a solid block of wood under the lower sash of the window so as to raise the top of the lower sash above the

bottom of the upper, admits the air in an upward direction to the ceiling above the heads of the occupants. Holes bored in a perpendicular direction in the bottom of the upper sash, louvered panes to replace one of the squares of glass, an arrangement for allowing one of the squares of glass to fall inwards upon its lower border and providing it with side cheeks, or a double pane of glass in one square open at the bottom outside and at the top inside—all effect the same purpose and are simple and inexpensive contrivances. Wall inlet ventilators, as the Sherringham valve and Tobin's tubes, are constructed on the same principles, fresh air, which in towns may be filtered through muslin or cotton wool, or made to impinge upon a tray containing water so as to deposit its sooty particles, being admitted at a height of about 6 feet from the floor and directed upwards towards the ceiling. The usual outlet for vitiated air is the chimney-flue, and this for an ordinary medium-sized sitting-room, with a fire burning, is sufficient for three or four people, provided no gas is alight, or the gas lamp has its own special ventilating arrangements. With an ordinary fire, from 10,000 to 15,000 cubic feet of air are drawn up the chimney in an hour. Valves placed so as to open into the flue near the ceiling are sometimes used as outlets for foul air, such are Neil Arnott's and Boyle's valves, which permit air to pass into the flue, but prevent its return; the only objections to their use are that they occasionally permit the reflux of smoke into the room, and their movements backwards and forwards cause a slight clicking noise. In all new buildings where efficient ventilation is desired, it would be preferable to construct a shaft at one side of, or surrounding the chimney-flue, with an inlet near the ceiling of the room and the outlet at the level of the chimney top, so that the air escaping from the room would have its temperature kept up by contact with the chimney, thus aiding the updraught, whilst the risk of reflux of smoke would be avoided. In all new domestic buildings a very great improvement might be effected by providing for the warming of the air before its entry into the apartments. The window and wall inlet ventilators just described are occasionally productive of draughts in cold weather, so that it is more usual to find them closed or stopped up than in action, or else admitting a very insufficient supply of air; but if the air be warmed before admittance to an agreeable temperature a very large amount may be allowed to enter without the fact being known to the occupants. The ventilating stove invented by Captain Galton, the Manchester school grate, and other forms effect this purpose in the following manner: Behind the grate, which is lined with fire-clay, is a chamber into which fresh air is admitted by a pipe from the outside. The air, here warmed, is admitted into the room by a pipe opening at about the level of the chimney breast and guarded by a grating which can be opened or closed as found convenient. In the Manchester school grate the warmed air is admitted by vertical pipes, like Tobin's tubes, opening on a level with the chimney-piece. The danger in these grates is that cracks may be formed by the heat of the fire in the joints or in the cast-iron plates which surround the air chamber, and thus direct communication be established between the grate and air chamber with the result of deleterious products of combustion being admitted into the air of the room. When the stove is lined with fire-clay there is no danger of the air in the chamber being overheated, producing charring of the organic matter in the air and an offensive smell, which is so often noticed around stoves where this precaution has not been taken. In Mr. Saxon Snell's ventilating thermhydric stove the fresh air is warmed by passing over hot water pipes in the stove before entrance into the room, the hot water being derived from a small boiler at the back of the grate. The temperature of the water is not high enough to overheat the air.

Gas is being gradually introduced for heating purposes, and with a reduction in its price we may look forward to its more extended use. There are several ventilating gas stoves by which air is admitted into a room warmed after passing through the stove. It is important to regulate the heat carefully so as not to overheat the stove and the air which is passing through. In churches and other public buildings air is usually warmed before entry by passing over hot water pipes which circulate around the building under the floor. In all large buildings the combustion of gas may be made a very effective means of getting rid of foul air. It has been found by experiment that the combustion of one cubic foot of coal gas causes the discharge of 1000 cubic feet of air. In theatres where gas, although being gradually replaced by the electric light, is still much used, the extraction of foul air from the roof of the building by the sunlight burners presents no difficulty. The difficulty experienced is the introduction of fresh air from below without causing draughts. In private houses the use of an extraction shaft over the gas chandelier or a Benham's ventilating globe light, or a Mackinnel's ventilator greatly aid the extraction of foul air from the ceiling, whilst the two latter are also useful in providing inlets for fresh air which enters slightly warmed near the ceiling, and is then directed horizontally by flanges so as to be distributed over the room. Outlets in the ceiling of a room may become inlets when a strong fire is burning, as the draught up the chimney will overbalance the extractive power of the gas and cause all other openings into the room to be inlets. We may here mention an ingenious method for warming the air admitted by Tobin's tubes into a room: a row of small Bunsen burners encircles the tube at its foot, and the products of combustion are conveyed away by a tube which surrounds the Tobin and opens into the outer air.

In large public buildings, where expense is no object, a combined method of ventilation by propulsion and extraction presents many advantages. The amount of air admitted can be easily regulated, warmed, cooled, or moistened, and freed from impurities by filtration, and enormous volumes are capable of being so supplied by propulsion and removed by the extractive powers of a furnace. In the Houses of Parliament where this system is in operation, air is propelled by rotatory fans along conduits to the basement, where it is warmed in winter by passing over steam pipes, and then passes upwards through shafts into the space beneath the grated floor of the House. The heat can be regulated by covering the steam pipes with woollen cloths, and in summer the entering air can be sprayed with water or cooled by passing over ice in the conduits. The vitiated air in the House passes through a perforated glass ceiling in the roof, and is then conducted by a shaft to the basement of the Clock Tower, where it passes into the flue of a large furnace.

The introduction of electricity for lighting and of gas for heating purposes will, in the case of both public and private buildings, considerably modify the methods of ventilation now most generally used.

CYCLES

THE Institute of Mechanical Engineers held a general meeting in the Corn Exchange, Coventry, on the afternoon of Wednesday, October 28, Mr. Jeremiah Head, President, in the chair, when the Secretary read a paper by Mr. R. E. Phillips, of London, "On the Construction of Modern Cycles," of which an abstract follows:—

The cycle industry in this country has grown with such rapidity and has already assumed proportions of such magnitude as to lead the author to hope that the present paper may prove of some interest to the Institution. It would not be possible within any reasonable limits to do justice to all matters connected with cycles; and he therefore purposes dealing only with their general con-

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struction, pointing out the underlying principles, and describing the various types at present made in order to show how far these principles have been carried out, and what degree of perfection has already been attained.

Power.—The experiments of Messrs. S. J. and G. S. Stoney show that with a lever action bicycle the power necessary to produce speeds of from six to fourteen miles an hour on an average road ranges from one-seventh to one-third of a horse-power; but the author thinks that less than this would be necessary with an ordinary rotary action bicycle.

Bicycle.—Gavin Dalzell, a cooper of Lesmahagow, in Lanarkshire, in 1836 first fixed a pair of cranks to one of the wheels of a hobby horse, and may therefore be considered the inventor of the bicycle. In 1868, Mr. Cowper, a past President of the Institution, specified, amongst other things, suspension wheels with wire spokes, hollow felloes, rubber tyres, and anti-friction roller bearings, and may thus be considered the inventor of the suspension wheel. Without these features or some modifications of them no cycle at the present day is satisfactory.

Tricycle.—Although the tricycle was invented contemporaneously with the bicycle it did not attract much attention until six years later.

Statistics.—Over one thousand patents were applied for for improvements relating to velocipedes before the end of 1883, and during 1884 (under the new Act) 637 applications were filed. There are 170 firms who devote themselves exclusively to cycle making, and turn out over 500 different machines. The trade employs 3000 men in Coventry and at least 5000 in the United Kingdom. About 40,000 machines are sold annually, of the gross value of about 800,000*l.*

Performances.—The following "records" are given:—

On a Racing Path

Distance run, miles	Duration of race, hours: Bicycle	Tricycle	Mean speed, miles per hour: Bicycle	Tricycle
1	0·044	0·050	22·6	20·0
5	0·238	0·272	21·0	18·4
10	0·489	0·543	20·5	18·4
20	0·985	1·145	20·3	17·5
25	1·278	1·442	19·6	17·3
50	2·733	3·054	18·3	16·4
100	5·835	6·726	17·1	14·9

On Ordinary Roads

Journey	Bicycle Hours	Bicycle Days	Tricycle Hours	Tricycle Days
Distance of 100 miles	7·19	—	7·58	—
Land's End to John O'Groat's (about 900 miles)	160·17 =	6·67	197·33 =	8·22
Land's End to John O'Groat's and back, and thence to London, about 2050 miles	456 =	19		
Greatest distance in 24 hours	266¼ miles		231½ miles	
Mean speed for the 24 hours, miles per hour	11·1 ,,		9·6 ,,	

From these performances it appears that the bicycle has an advantage of from 2 to 2½ miles per hour.

Classification—

Bicycles

1. Bicycles of the ordinary type.
2. Safety Bicycles, which may be subdivided into—
   a. Dwarf bicycles with geared rotary action.
   b. Dwarf bicycles with lever action.
   c. Safety bicycles with steering-wheel in front.
3. Tandem bicycles.
4. Otto bicycle.

Tricycles

1. Single drivers, which may be subdivided into—
   a. Rear steerers.
   b. Coventry rotary, side steerer.
   c. Double front steerers.
2. Double drivers, which may be subdivided into—
   a. Those driving by clutch action.
   b. Those driving by differential gear.
3. Humber tricycles.
4. Hand power tricycles.
5. Sociables.
6. Tandems.
7. Carriers.

All these may be again subdivided as driven by "rotary" or "lever" action.

BICYCLES

Ordinary Bicycles.—The ordinary type of bicycle is so familiar that it need not be referred to at any length, especially as the details of construction will be dealt with later on. Being supported on only two points it is unstable, so it tends to fall one way or the other. Equilibrium is maintained by steering to that side to which it tends to fall. As the rider is seated only a little behind the centre of the driving wheel he is able by his feet alone to control the steering and so maintain his balance. When working the rider must counteract the thrust of his feet by pulling at the handle bar with his arms alternately on either side. It is this combined action which renders the riding of a bicycle so difficult to learn. The bicycle cannot be driven along a perfectly straight line, hence anything that interferes with the freedom of steering, as the groove of a tram line, makes the balance impossible.

Weight.—The weight of an ordinary roadster bicycle varies from as many pounds as its driving wheel is inches in diameter down to from 15 to 20 lbs. less than this. A racing bicycle weighs from 18 to 25 lbs, according to size. The proportionate weights of the several parts were given.

Vibration, which is the chief source of discomfort in most cycles, is mitigated by the use of india-rubber cushions between the wheel bearings and the forks, between the backbone and the spring, and between the head and the handle.

A spring fork was shown which serves to diminish the vibration produced by the small wheel of a machine.

Dwarf Bicycles with Geared Rotary Action.—Machines of this class have a smaller driving wheel connected with the pedals by chains and chain wheels. This makes it possible to "gear up" the driving wheel so as to be equivalent to one of any size. The high gearing thus introduced is the cause, in the author's opinion, of their ease of propulsion and speed.

Dwarf Bicycles with Lever Action.—The "Facile" bicycle is a prominent example of this type of machine. The motion of the feet is simply reciprocating, and as the wheel is not "geared up" the feet keep time with the driving wheel.

The 'Xtraordinary is another example of a lever action machine. In this machine the fork rakes back to a great extent so that the rider is far behind the centre of the driving wheel, but the pedal levers bring the pedals to a convenient position. Their path is oval. These machines are made of the full size.

Safety Bicycles with Steering Wheel in Front.—In machines of this class the rider sits well over the driving wheel, which is behind. A single chain is sufficient, as in this kind of machine there is a "through" crank-axle. In a modification of this pattern a divided crank-axle is employed, which allows the rider to be still more over the driving wheel. The frame, moreover, is made capable of swinging and of being locked in various positions, so that the rider can place himself in the best position under all conditions.

Machines of this type are rather sensitive in the steering, but as automatic contrivances to keep the steering wheel running straight are apt to interfere with that freedom which is necessary for the balance, such devices are not altogether desirable.

In these machines the feet cannot be used to control the steering as in an ordinary bicycle, but the author of the paper has contrived a means for effecting this. On

the centre of the crank axle is a spherical boss, on which can swivel, but not turn freely in all directions, a large double hollow chain wheel kept parallel to the driving wheel by two idle rollers. As a matter of fact the crank axle swivels within this chain wheel and the brackets which support it being rigidly connected with the handle bar serve to steer the machine.

Tandem Bicycles.—At present there are only two makes of tandem bicycle, each invented by Mr. Rucker. The earlier one is constructed of two ordinary bicycle driving wheels complete in their forks, which are then connected by a backbone containing an axial joint. Each rider drives, steers, and balances on his own wheel independently of the other, but of course the rear must follow within a foot or so the path of the one in front. Although this machine is very fast, lighter than two ordinary bicycles, and almost entirely free from vibrations, there is an element of danger about it that militates against its general use, inasmuch as it demands to a certain extent a unity of thought and action on the part of both riders.

A very satisfactory tandem has been arranged by the author, a modification of this, in which the rear wheel is replaced by the driving wheels of an ordinary Humber tricycle, the connecting bar of course being modified to suit the altered conditions. The later tandem bicycle eclipses the earlier; it is probably the fastest machine in existence. It is constructed on the lines of a dwarf geared bicycle. The seat for the front rider is mounted immediately over the centre of the driving wheel, while the rear rider who alone steers and manages the machine is about midway between the two wheels. Divided pedal axes are mounted fore and aft of the centre of the driving wheel. The weight of this bicycle is only 55 lbs.; it is therefore the lightest machine yet made to carry two riders.

Otto Bicycle.—This peculiar machine, which is due to the brother of the inventor of the gas engine known by the same name, is almost more nearly allied to a tricycle than to a bicycle proper, but as it has only two wheels and consequently requires the balance to be still maintained by the rider, it is rightly called a bicycle. The wheels are the same size, and are here mounted loose on the same axle, parallel to each other and both of them are drivers. The rider sits between them and works a continuous pedal crank-axle, the position of which when he is seated is below and slightly in front of the axle carrying the driving wheels. The crank axle is connected with the driving wheels by endless steel bands passing round plain pulleys on the ends of the crank-axle and on each wheel. The bands are kept taut by tightening springs, and the machine is steered by slacking one or other of them, which causes the corresponding driving wheel to lose motion, and therefore the other wheel runs round it. If a very sharp turn has to be made suddenly, a brake is applied to one wheel at the same time that its driving band is slackened, which causes the machine to turn round in a circle upon that wheel as a centre. This machine having no small wheel fore or aft, the rider, while steady sideways, has to balance himself in the direction of his motion, which he is enabled to do through the medium of the pedal crank axle; by pressing on the forward pedal, if he is falling forwards, he throws his weight backwards and conversely by pressing on the rear pedal he throws his weight forwards. To preserve him from actually capsizing backwards a safety tail projects behind the seat, which will bear on the ground whenever the seat is tipped too far back.

Among the many beautiful features presented by this machine the best seem to be: (1) the balance whereby the rider is always in the best position to utilise his strength and weight notwithstanding the various gradients; (2) the nicety by which it can be steered; (3) its tendency to run in a straight line without any effort on the part of the rider; (4) its freedom from vibration; (5) the circumstance that it makes only two tracks.

TRICYCLES

The tricycle presents far greater difficulties than the bicycle. It is necessary that each wheel shall be free to move in its own direction independently of the united action of the other two. For running in a straight line all three wheels must be parallel; whilst for running round a curve, one or more of the wheels must be turned until the centre lines of the axles intersect in plane, their point of intersection being the centre of the path described. Besides being independent in direction of running, each wheel must also be capable of revolving at a greater or less speed than the others. It is also essential that only so much of the rider's weight shall be borne by the steering wheel or wheels as is necessary to ensure their proper action. Owing to the variety of ways in which these principles can be carried out practically, it is easy to account for the variety of tricycles constructed.

Single-driving Tricycle.—The simplest form of tricycle is that with only one driving wheel, either or both of the others being used for steering. The single driving rear-steerer is now practically obsolete.

Coventry Rotary Tricycle.—Another single driver, known as the "Coventry rotary," has the large driving-wheel on one side, and two small steering wheels on the opposite side, arranged to turn together in contrary directions for steering. The double steering counteracts the evil of one-sided driving. Though one of the first machines introduced it is still largely in use, its advantages being that it is simple, it makes only two tracks, and it is narrow enough to pass through an ordinary doorway; this, however, diminishes its natural stability.

Front Steering Tricycle.—A single driving machine of this class exists which is steered by the two front wheels, and driven by the rear wheel, but there is not sufficient weight on the driving wheel.

Double-driving Tricycles.—In these the two driving wheels are always placed parallel and opposite to one another, with the steering wheel in front or behind, and generally central. It is sometimes placed on one side when the tricycle makes only two tracks. There are two methods of double-driving: firstly, by clutch-action; secondly, by differential or balance gear.

Double-driving by Clutch Action.—In this plan the two driving wheels are locked to their axle only when the machine is being driven forwards in a straight line, but in running round a curve the outer wheel overruns the clutch and the inner wheel alone drives. In the Bourdon Clutch, which is most generally used, a disk has its edge cut away so as to form three or more inclined planes. In each of the spaces between these recesses and an outer ring is a hard steel roller, which jams when the clutch drives the wheel, but which does not hinder the wheel from running ahead of the clutch.

A clutch machine cannot, without extra gearing, be driven backwards, nor can it be retarded except by the action of the brake. On the other hand the free pedal is a convenience. Various attempts have been made to construct a clutch which shall drive either way, but hitherto without success, in consequence of the loss of time between the forward and the backward grip. The author of the paper is now at work on this problem.

Double Driving by Differential or Balance-Gear.—This other mode of double driving, so called because the power is divided or balanced between the two driving wheels, depends on the action of an epicyclic train, in which the two primary wheels are connected with the driving wheels of the tricycle, while the arm or train which connects them is driven. The simplest form invented by Starley consists of three bevel wheels. Here the arm or axis of the middle one being carried round, drives the other two and

hence the driving wheels, which nevertheless can move independently. Other gears were spoken of, and a figure of the Sparkbrook gear given.

Each kind of driving has its advantages. When running straight the clutch system drives each wheel, and when one wheel meets with more resistance than the other, as much extra force as is necessary is supplied to it, so that obstacles are surmounted with less chance of swerving. In going round a corner only the inner wheel is driven.

With balance-gear the same force is applied to each wheel, whether the path is straight or curved.

A rear steering tricycle driven by clutch action, a rear steerer driven by differential gear, and a front steerer driven by differential gear were exhibited.

Humber Tricycle.—Among tricycles driven by differential gear, the Humber is quite peculiar. The rider sits astride a back bone carrying a trailing wheel, and steers by turning the axle of the two driving wheels by means of a handle bar. The differential gear is essential to a machine of this type, as it does not interfere with the steering, while it is at all times perfectly double driving.

A curious machine—a modification of the Humber—was shown, in which all three wheels take part in the steering, but of entirely novel and elegant design.

As with bicycles, so with tricycles, the power may be applied in one of two ways: either by rotary action or by lever action. For changing the power, levers are more convenient, but they do not compare with rotary action in point of speed.

Omnicycle.—One of the most successful lever machines is the omnicycle, a machine in which the pedals are connected with the circumference of a segment by means of a leather strap. When one pedal descends it causes the segment on the other side to return and raise the pedal on that side. The segments can be expanded to various extents, so that the power is applied with various degrees of leverage according to the work to be done.

Direct-Action Tricycle.—The simplest rotary tricycle has no chain or connecting mechanism; the pedals are on the main axle, which is cranked. This gives rise to the insuperable objection of instability as the rider is necessarily perched up high. By the use of hanging pedals a few inches are gained.

Transmission of Driving-power.—Reverting to the ordinary type of tricycle in which the power is applied to a crank axle and transmitted thence to the main axle, there are three plans commonly in use—(1) by chains or bands: (2) by gear wheels; (3) by cranks and coupling-rods.

Driving-Chains. These are the most popular means of transmitting power, as they offer the greatest facilities for gearing up or down. The Morgan and the Abingdon chain were figured and described.

Driving-Bands.—Steel bands, plain or perforated, have been used with some success. The Otto bicycle is the only machine in which plain bands are used for driving. The power spent in continuous flexure of the bands outweighs, in the author's opinion, any other advantages they may possess.

Gear-Wheels.—In this system an intermediate wheel gears with those on each axle; but as the wear cannot be taken up without destroying the pitch, the plan is hardly satisfactory. Rollers are occasionally fitted over the teeth of the intermediate wheel.

Coupling-Rods.—Coupling-rods are used on a few machines; with the exception that they will not permit of gearing up or down and that they cannot be used with differential gear, they give very good results.

Another method due to Mr. Boys, in which eccentrics and steel bands are employed, was also referred to.

(*To be continued.*)

NOTES

DR. ASA GRAY was presented, on November 18, being the seventy-fifth anniversary of his birth, with a silver vase, by the botanists of America. It is described by *Science* as being about eleven inches high, and is appropriately decorated with those plants which are distinctively American, and which are most closely associated with Dr. Gray. The place of honour on one side is held by *Grayia polygaloides*, and on the other by *Shortia galacifolia*. Among others, *Aster Bigelovii*, *Solidago serotina*, *Lilium Grayi*, *Centaurea americana*, *Notholæna Grayi*, and *Rudbeckia speciosa*, are prominent. The workmanship is described as highly artistic, as well as remarkably accurate. The vase stands on a low ebony pedestal, which is surrounded by a silver hoop, bearing the inscription:—

1810—November Eighteenth—1885
ASA GRAY
In token of the universal esteem
of American botanists.

The greetings by card and letter of the one hundred and eighty contributors were presented on a plain but elegant silver tray. They contained the warmest expressions of esteem and gratitude.

As we intimated last week, the death took place in Paris, on the 30th ult., of M. Bouley, President of the Academy of Sciences, after a long and painful illness. Although, says the *Revue Scientifique*, he did little original work in science, he exercised a wide influence on its general progress as well as on scientific education. He did much to raise in public consideration the art and science of veterinary surgery and medicine. Latterly, he became the ardent apostle of the teachings and discoveries of M. Pasteur, and to this work he devoted his lucid and vigorous eloquence. His books on experimental disease and on contagion are models of scientific style, as his lectures at the Museum were models of instruction.

THE death is announced, at the age of eighty years, of Prof. Giuseppe Ponzi, the Italian geologist.

THE fifth edition of the "Admiralty Manual of Scientific Inquiry" is now being prepared for press, under the editorship of Prof. Robert S. Ball, F.R.S., Royal Astronomer of Ireland The following is a list of the articles, with the names of the authors or revisers:—Astronomy, by Sir G. B. Airy, K.C.B., F.R.S.; Hydrography, by Capt. W. J. L. Wharton, R.N., Hydrographer of the Admiralty; Tides, by Prof. G. H. Darwin, F.R.S.,; Terrestrial Magnetism, by Prof. G. F. Fitzgerald, F.R.S.; Meteorology, by Robert H. Scott, F.R.S.; Geography, by Sir J. H. Lefroy, F.R.S.; Statistics, by Prof. C. F. Bastable, M.A.; Medical Statistics, by W. Aitken, M.D.; Ethnology, by E. B. Tylor, F.R.S.; Geology, by Prof. Archibald Geikie, F.R.S.; Mineralogy, by Prof. W. J. Sollas, D.Sc.; Earthquakes, by Thomas Gray; Zoology, by Prof. H. N. Moseley, F.R.S.; Botany, by Sir J. D. Hooker, K.C.S.I., F.R.S.

NOW that M. de Lacase-Duthiers has completed his arrangements for the marine laboratories at Banyuls and Roscoff, his friends and admirers have deemed the moment a suitable one for manifesting their sense of the value of his services to the study of zoology in France, and to zoologists all over the world, and it is hoped that all those who are connected, either by their studies or their sympathies, with the zoological school founded and directed by him, will join in the work. The proposal is to have his portrait etched by one of the best French artists, and to give a copy to each subscriber of ten francs or more. The number of copies will be strictly limited to the number of subscribers. The Universities or schools of Athens, Paris, Caen, Geneva, Liége, Cairo, Edinburgh, Clermont, Besançon, Lyons,

and Poitiers are represented on the Committee. Subscriptions may be sent, before December 16, to M. J. Joyeux-Laffuie, of the Faculty of Sciences, Besançon, or, in this country, to Prof. Geddes, 81A, Princes Street, Edinburgh.

THE new balloon constructed by the Meudon aëronauts, will be directed by a steam-engine, as advocated by M. Henry Giffard. Electricity will be quite given up, owing to its want of power for continuous action. From the reports to be published in the next number of the *Comptes rendus*, it appears that a velocity of six metres per second was obtained.

THE Tokio Correspondent of the *Times* describes a strange linguistic revolution which is coming over Japan. Hitherto the Japanese language has been written by Chinese ideographs, or pictorial symbols, of which many thousands had to be learned by every youth. There were also two syllabaries or alphabets which were used by the common people, but no one could enter on the path of knowledge without first acquiring a knowledge of the Chinese characters, "a task which not only needed a very heavy expenditure of time, but was also calculated to stimulate the memory in an abnormal degree at the cost of other not less important mental faculties." Moreover, with the new science from the west before them, Japanese youth "could hardly afford to spend years and warp their brains in learning the single accomplishment of writing thoroughly their own tongue." A movement, which appears to be as national as such a movement could be, has now been set on foot to discard all existing methods of writing Japanese in favour of Roman letters. A society called the Roman Alphabet Association has been founded for the purpose of disseminating knowledge on this subject and of providing a uniform method of transliteration. It now consists of nearly 6000 of the leading men in the governing, educated, and literary classes. Stupendous as this change may seem to us, there is really no reason why it should not successfully be carried out. It meets in Japan a crying evil, which stunts the mental growth of its youth, places a barrier between them and the science and discoveries of the age, and which haunts and embarrasses them in their subsequent studies unless they acquire a foreign language at once in order to get rid of this incubus. Besides, the Japanese language is now written in borrowed symbols; Chinese characters are as alien to it as Roman letters; but the former have been in use a thousand years, and if the Japanese can now succeed in getting rid of them they will have accomplished a revolution more marvellous and not less beneficent than any they have passed through in the last seventeen years.

WE have received from Mr. Twining a pamphlet, of which he is the author, on "Science for the Middle and Upper Classes," which is intended for the consideration of those interested in educational progress (London: J. J. Griffin and Sons, 22, Garrick Street). He first deals with the chief purposes of scientific instruction, which he classes under the heads "bionomic" ("bionomy" being his convenient expression for the science of daily life) "intellectual," "technical," and "professorial." He then draws up and discusses a scheme of scientific teaching extending over the whole school period of a boy. There are, in addition, numerous observations on the teaching f various branches of science. Mr. Twining's pamphlet is herefore essentially for the teacher, and, as he has evidently devoted great attention to the subject, and is himself engaged in the practical work of education, his pamphlet should prove useful and suggestive.

IN the *Revue Scientifique* M. de Lacaze-Duthiers describes a curious phenomenon which he has observed in a parrot belonging to him. The bird is very intelligent, having an excellent memory for his friends and his enemies; of this trait and other marks of intelligence the writer gives several instances. The point of the article, however, is this:—The parrot has manifested an extraordinary affection for a little boy named Raymond, but usually called by the Southern diminutive, "Momon." The child called M. Duthiers's attention one day to the fact that, whenever he played with the bird, the eyes of the latter became quite red. When the boy went away, the parrot would call out his name perpetually; when he returned, it would walk to and fro on its perch, exhibiting every mark of extreme pleasure; and the eyes invariably grew red. At these times it would allow no one else, however friendly, to approach the cage; it would not eat its most favourite food. When the boy hid himself for a moment, the eyes became yellow, but suddenly reddened again when he reappeared. This phenomenon was observed only with this particular child, and with no one else. When the boy went to school, or when the bird was brought to Paris from the country, it ceased completely. An examination of the bird's eye showed that the pupil is large, and usually dilated. The iris is only represented by a circular yellow band, bordered externally by a bright red strip. The pupils of parrots are known to be very mobile. When the bird manifests joy, it contracts the iris *voluntarily*, the yellow disappears, and the red strip occupies its place, spreading itself out all over the surface of the back of the anterior chamber of the eye, giving the striking red tint observed first by the child. Here, then, is a bird, intelligent, and full of affection for a particular person, manifesting its joy by the contraction of its pupils, and thus voluntarily modifying the colour of its eyes. When violently angry, some streaks of red dart across the eye, but they never remain as in the other case. It is curious, concludes M. Duthiers, to see a phenomenon, regarded as independent of the will in the superior animals, thus found in association with feelings and acts which determine joy or anger, and which is apparently as voluntary as the movements of the feathers and all other essentially voluntary acts.

HERR STEJNEGER continues to supply *Naturen* with interesting reports of his recent boating expeditions in Behring's Sea. In the latest of these we find much valuable information in regard to important changes to which the fauna of these regions is being subjected through the reckless destruction of some animals, and the rapid spread of others by the introduction, through the agency of man, of previously unknown species. Thus, while there were upwards of 5000 sea-otters (*Latax lutris*) killed on the Prybilof Islands in the first year of their occupation, after six years not one of these animals was to be found on the spot, nor have they ever reappeared there during the century that has elapsed since then. At Mednij, on the other hand, where otter-hunting is conducted with moderation and under legal restrictions, there is no marked diminution in the numbers of these animals, and there is at present every prospect that the supply of skins will continue to yield a fair source of wealth to the inhabitants. The killing of foxes is similarly controlled in some districts, where the natives refuse to allow Master Reynard to be hunted, excepting in the last three months of every second year, during which time no one is allowed to fire a gun, or drive with dogs along the coast, lest the sound of the shots and the barking should interfere with the success of the licensed fox-hunters, who on these occasions occupy the earth huts specially set apart for their use in the several districts.

OWING to the moderation shown in its pursuit, the Behring Straits fox, known as the blue fox, from the colour of its skin in winter, seems for the present to be in no danger of dying out, several of these animals being generally visible on the strand of every little bay, where they arrest attention by their loud, howling bark, which is often continued hour after hour through the night. Till recently they might have been regarded as the only terrestrial quadrupeds on Behring's Island; but in the present day the brown field-mouse (*Arvicola rutila*), which was unknown eleven years ago, has made good its footing on the

island, swarming over every district, from the heights of the fjelds to the flats of the tundra, and from the interior to the most exposed rocks along the coasts. Till 1874 the mouse family was unknown on the island, the oldest inhabitants never having seen one of the species prior to that date, when the gray mouse (*Mus musculus*) unexpectedly made its appearance, having probably been introduced in a cargo of flour from San Francisco. The advent of these pests was followed a few years later by that of the more destructive brown field-mouse, a phenomenon which the simple natives explain to their own satisfaction by assuming that the shorter-tailed rodent is a descendant of the long-tailed gray mouse, which had thus changed its colour and appearance the better to adapt itself to its novel terrestrial life. Mednij is still free from these undesirable immigrants, but the fact is not regarded in the light of a happy exemption by the inhabitants, who, considering this short-tailed little quadruped as specially adapted for a domestic pet, petitioned the authorities to provide them with an adequate supply. Their eager desire for the acquisition of rodents has, fortunately for them, been only so far complied with that, in place of the coveted voles, a few rabbits were sent to the island.

Naturen draws attention to the notices to be found among Scandinavian authorities of the observation in past times of the same after-glow in the sky which has in recent years been made the subject of so much discussion. Thus we learn from a Danish journal that the glow in the skies observed in 1636 by seamen navigating the northern seas was ascribed at the time to the eruption of Hecla which occurred in that year. From the same source we derive a circumstantial notice of a similar phenomenon observed in Copenhagen on May 29, 1783, which continued, with slight variations, till the close of the following September. In the months intervening between these dates the heavens were illumined by a constant red glow, although the sun appeared by day like a faint disk, and was wholly invisible at its rising and setting. The air is said to have remained unaffected by cold or heat, rain, or dry weather. The superstitious were not slow in interpreting these unwonted phenomena to portend great national troubles, while some persons even regarded them as the immediate forerunners of the end of the world. After a time, however, news reached Denmark that there had been an unusually violent eruption of the Skapta Jökul in the previous spring, and thenceforth a conjecture was advanced that the remarkable redness of the sky might, as in 1636, be connected with the great outbreak of volcanic energy in Iceland.

A NEW discovery of apatite is reported from Stavanger, where, about 30 kilometres east-south-east of the spot at which Herr Enoksen found this mineral last summer, its presence has again been detected in a granitic formation near Lerwik. Here it appears in a finely granulated form intermixed with nickel and magnetic iron pyrites, the masses varying in size from 18 to 38 inches in diameter, and lying detached in a dark deposit, which is believed to be mica diorite. In the matter of mineral finds of real value the Stavanger district has been specially favoured in recent times, and we are glad to learn that the sanguine expectations excited by the accidental discovery in 1881 of a zinc mine near the head of the Sövdefjord, have been fully justified by the result of the yields. On a more careful examination it has been ascertained that these mineral deposits extend horizontally for a distance of 80 metres, while they have been traced to a depth of 60 metres. The ore is blende, or sulphide of zinc, which appears in flat perpendicular masses, from 50 centimetres to 4 metres in thickness.

THE Russian Government has assigned the sum of 255,500 roubles to be expended during the year 1886 in new geodetical surveys in Ferghana, the territories bordering on China, the Usuri district, the Transcaspian province, and Finland.

THE Government of Tasmania are making arrangements upon a large scale for naturalising lobsters, crabs, turbot, brill, and other European fishes in the waters of that country. The various consignments will be shipped at Plymouth, and transported through the medium of the steamship companies trading between London and Hobart. An exhaustive report has been published by the Government of Tasmania, setting forth the objects in view, and giving suggestions for carrying them into effect. The report adds that while the achievement of the acclimatisation of European fishes would lay the foundation of new and very valuable fishing industries in Tasmania, it might also prove a highly remunerative commercial enterprise to the shipping firms under whose auspices the operations wil be conducted. Applications have been made in various quarterl for supplies of fish, which have been satisfactorily responded to. Special tanks are being prepared, as well as apparatus, in order to provide for the necessities of the fish *en route* which, it is anticipated, can be transmitted with little difficulty. The success that has hitherto attended the acclimatisation of certain European fishes in New Zealand has had the effect of inspiring the Government of that colony with considerable enterprise in developing their fisheries. They are now about to collect the ova of *Salmonidæ* from English waters in large numbers through the instrumentality of the National Fish-Culture Association, and other bodies, with a view to rearing the fry in New Zealand. A shipment of eggs will also shortly be sent to Australia, where great success has attended the introduction of our fishes, except in a few instances, when failure resulted more from misadventure than from the impracticability of the attempt.

A DREADFUL earthquake occurred in Algeria on the night of December 3–4. The centre of commotion seems to have been located near M'sila, a small town in the interior. The place was disturbed a second time on the following morning. The last commotion was more destructive than the first. The number of victims is estimated at one hundred. The commotion was felt at Setif and at Moscara, whose distance is about 400 kilometres. Their direction was east to west. The difference was 7 seconds at Setif, and 8½ at Moscara, where three different shocks were felt. The commotion was noted also in Algiers without any accident being recorded. According to latest news, the series of earthquakes is continuing with unabated energy. We learn that on the night of the 4th to the 5th inst. a port of Bousaada, a town of 6000 inhabitants, almost exclusively Arabs, has been partially destroyed. The church and seventy-one houses have been demolished; the victims are not numerous, all the population having encamped in the fields. This town is the centre of a large market, celebrated in all the south of the province of Algiers, 254 kilometres south of the city. Another telegram states that other commotions were felt on the 6th at M'sila for the second time. These last shocks are reported very heavy; time, 2 and 4 p.m. The time appears to have been the same at M'sila.

OUR Paris correspondent writes that in relation to the balloon which is said to have been seen over Bermuda in September, no ascent took place in France which can account for it.

WE learn with regret that M. de Mortillet, the sub-Director of the Prehistoric Museum at St. Germain, has been obliged to resign owing to his election to the French Lower House as a Member for Versailles. A competition has been opened to fill up the post vacated by his resignation. The Society of Anthropology and similar scientific institutions have signed a recommendation to the Minister of Public Instruction on behalf of M. Adrien de Mortillet, who has been associated with his father in the publication of his recent works on prehistoric science.

THE additions to the Zoological Society's Gardens during the past week include a Sly Silurus (*Silurus glanis*), European, a Thunder-fish (*Misgurnus fossilis*), a Ground Loach (*Cobitis tænia*) from Danzig; a Barbel (*Barbus vulgaris*), a River Bull-head (*Cottus gobio*) from British fresh waters, presented by Mr. Alban Doran, F.R.C.S.; one hundred Golden Carp (*Carassius auratus*) from Spain, presented by Messrs. Paul and Co.; a Black-shouldered Kite (*Elanus cœruleus*) from Africa, received in exchange.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *DECEMBER* 13-19

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on December 13

Sun rises, 8h. 0m.; souths, 11h. 54m. 33·8s.; sets, 15h. 49m.; decl. on meridian, 23° 12′ S.: Sidereal Time at Sunset, 21h. 19m.

Moon (at First Quarter on Dec. 14) rises, 11h. 48m.; souths, 17h. 16m.; sets, 22h. 53m.; decl. on meridian, 6° 51′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	8 53	12 48	16 43	23 8 S.
Venus	11 4	15 18	19 32	20 5 S.
Mars	23 0*	5 43	12 26	7 52 N.
Jupiter	0 45	6 47	12 49	0 23 S.
Saturn	16 49*	0 58	9 7	22 27 N.

* Indicates that the rising is that of the preceding day.

Occultations of Stars by the Moon

Dec.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
17	μ Piscium	5	1 47	2 40	159 308
18	B.A.C. 741	6½	3 9	3 23	66 34
18	B.A.C. 987	6½	23 2	0 2†	162 284

† Occurs on the following day.

Phenomena of Jupiter's Satellites

Dec.	h. m.		Dec.	h. m.	
13	7 14	I. tr. ing.	16	1 19	I. occ. reap.
14	3 24	I. ecl. disap.	17	7 2	II. ecl. disap.
14	6 51	I. occ. reap.	18	4 36	IV. ecl. disap.
15	1 43	I. tr. ing.	18	7 23	IV. ecl. reap.
15	2 29	III. occ. reap.	19	4 36	II. tr. ing.
15	3 59	I. tr. egr.	19	7 24	II. tr. egr.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Dec.	h.	
17	7	Mercury at least distance from the Sun.
19	4	Mercury in inferior conjunction with the Sun.

Variable Stars

Star	R.A. h. m. s.	Decl. ° ′		d. h. m.	
R Vulpeculæ	20 59 17	23 22·0 N.	Dec.	15,	m
δ Cephei	22 24 54	57 49·6 N.	,,	16, 4	M
			,,	17, 18	m
R Cassiopeiæ	23 52 34	50 44·9 N.	,,	15,	m
U Cephei	0 52 8	81 15·3 N.	,,	14, 2 26	m
			,,	19, 2 5	m
T Monocerotis	6 19 1	7 8·9 N.	,,	17, 22	M
ζ Geminorum	6 57 17	20 44·3 N.	,,	18, 17	m
U Monocerotis	7 25 19	9 32·2 S.	,,	17,	M
T Geminorum	7 42 24	24 1·2 N.	,,	17,	M
W Virginis	13 20 6	2 46·9 S.	,,	18, 2	m
δ Libræ	14 54 50	8 3·7 S.	,,	15, 19 31	m
			,,	18, 3 22	m
U Coronæ	15 13 30	32 4·1 N.	,,	19, 21 25	m

M signifies maximum; *m* minimum.

Meteor Showers

A shower from the constellation of the Quadrant, radiant, R.A. 220°, Decl. 53° N., may be looked for throughout the week, after the moon has set.

A small shower with radiant in the constellation of the Lynx, R.A. 108°, Decl. 63° N., has been observed by Schmidt and Zezioli during this week of the year.

Stars with Remarkable Spectra

V Cygni R.A. 20h. 37m. 36s., Decl. 47° 43′·8 N., variable. Secchi's fourth type. The blue end is either wanting or extremely faint. The two dark bands usually seen in the orange in stars of this type seem absent, but the dark band in the yellow is very pronounced.

	R.A. h. m. s.	Decl. ° ′		
Birmm. 566	20 32 50	17 52·0 N.	Mag. 7·0	Three well-marked examples of the third type
Birmm. 569	20 40 13	17 40·5 N.	Mag. 6·8	
L.L. 40182	20 43 24	0 59·2 S.	Mag. 6·8	
ρ Persei	2 57 48	38 23·8 N.	Variable	Three typical representatives of the third class
α Orionis	5 48 58	7 22·9 N.	Variable	
π Aurigæ	5 51 24	45 55·5 N.	Mag. 4·8	

α Orionis and ρ Persei show many fine metallic lines beside the system of dark bands, shading off towards the red, which forms the characteristic of the third type of stellar spectrum. These brighter stars should be by all means examined with the fainter stars of the same type that the observer may become perfectly familiar with the characters and positions of the principal bands.

The *Dun Echt Circular*, No. 101, issued on December 5, from Lord Crawford's Observatory, says that the announcement has been received by Harvard College Observatory, from Dr. Lewis Swift, Director of the Warner Observatory, of the discovery of a comet by Barnard.

1885	Greenwich M.T. h. m.	R.A. h. m.	Decl. ° ′
Dec. 3	15 7.2	4 21·9	N. 4 45

Daily motion 35′ towards the north preceding.

The above message was forwarded by Prof. Krueger, of Kiel.

EXPLOSIONS IN COAL MINES[1]

II.

THE superficial observer, in noting the real progress made during the last few years in the facility and success with which the electric light has been utilised in a remarkable variety of directions, might have been pardonably led to the conclusion that there existed no very great difficulties in the way of at once presenting the miner with an electric light in almost as portable a form as a safety lamp—incomparably safer than the best of these—and capable of affording a much superior light for the entire duration of his longest working hours underground. A little inquiry into the subject demonstrated to the Royal Commission that such a conclusion would be at least very premature, and that, although the subject was one most worthy of patient pursuit, the attainment of really useful results was beset with formidable difficulties. It is one thing to announce in oracular fashion, as the *Times* did, in a leading article last June, "that collieries ought to be lighted in a way to dispense with safety lamps," and "that electricity is the one illuminating medium which can supply the light which miners want, without the flame which endangers them." It is quite another thing to apply the electric light with safety, even along main roadways, in mines in which fire-damp is prevalent. The writer of those lines would have been less confident in his assertions had he sought sufficient information to teach him that the fracture of a glow-lamp, or the rupture of a conducting wire in a mine, might be as much fraught with danger as the injury of a safety lamp or the lighting of a pipe. Had he, moreover, but learned by simple inquiry what progress had been made by patient workers (at the time he was inspired thus to write), towards setting aside those sources of danger and providing the miner with a portable and efficient self-contained lamp, he would certainly have hesitated to assert that "no proper zeal has been brought to bear upon the conquest of difficulties" in the application of electric lighting in mines, or to sneer at "the scientific brains, whom the public may encourage, though it cannot compel, to exert themselves as keenly for the

[1] Address of Sir Frederick Abel, Chairman of Council of the Society of Arts, delivered at the opening meeting, Nov. 18, 1885.—(Abstract by the Author.) Continued from p. 112.

illumination of a murky, dirty coal-pit, as in the transformation of a plot of ground in South Kensington into fairyland."

Attempts have been made in several of the mining districts to apply electricity to underground illumination; so far as distribution of the light in main roads is concerned, no great progress has been made, though there is now no reason why glow-lamps, protected after the manner in use at our Government Gunpowder Works (as shown in the recent Exhibition), should not be distributed to considerable distances along such portions of a mine. At Risca Colliery, in Monmouthshire, at Harris's Navigation Colliery, near Pontypridd, and at Earnock Colliery, at Hamilton, N.B., a commencement has already been made in this direction with satisfactory results. If, however, the miner is to have an electric lamp for lighting up drifts and working places, it must be supplied to him in a self-contained and really portable form, with absolute isolation of the glow-lamp from the surrounding atmosphere, and with a store of power sufficient to maintain an efficient light for ten or twelve hours.

The considerable improvements which have of late been effected in accumulators, and the advance which has also been made in the construction of constant primary batteries, have led to very important progress toward the attainment of these essentials. Mr. J. Wilson Swan, universally celebrated for his achievements in the matter of glow-lamps, has patiently pursued the subject, and has not long since succeeded in producing a lamp which, with its small storage battery, weighs little more than 8 lb., and which will furnish a light equal to from two to four times that given by the better forms of safety lamp for a duration of ten or twelve hours. Mr. Swan is sanguine that he will ere long be able to effect an important reduction in the weight and bulk of the lamp, and he is not less hopeful of elaborating a primary battery similar in portability and light-giving power, the substitution of which, if successful, for the accumulator would have the advantage of dispensing with the necessity for providing dynamo-electric machines and power for charging the storage cells. Other workers besides Mr. Swan, such as Mr. Coad and M. Trouvé, have been applying small primary batteries to the production of miners' lamps with some promise of success, although as yet the results furnished do not bear comparison with those obtained by Mr. Swan with the storage battery. Those who have spent any length of time under ground, especially in the very low workings which abound in coal mines, and at the high temperature which often prevails in the workings of deep mines, will have experienced the fact that any incumbrance may sometimes become very burdensome, and can well understand, therefore, that the weight and size of even the lightest form of battery with which an efficient light could be maintained for a sufficient length of time, may prove grave obstacles to its extensive employment. Moreover, as the electric light can afford no indication of the condition of the atmosphere in a mine-working, its employment may not allow of the safety lamp or some other testing appliance being dispensed with. But, even if used only as an auxiliary means of illumination in working places, such lights as those which Swan and others will supply, will prove very valuable, and especially so for exploring purposes, after accidents due to outbursts of gas, when the best safety lamps may be of little use, even if they continue to burn. Such electric lamps must indeed become formidable competitors of the Fleuss lamp (included in the recent Exhibition), which has, in conjunction with the portable apparatus for the supply of respirable air to explorers, already performed important service in rendering access to mine-workings possible where an ordinary lamp could not burn, and where the atmosphere was too foul to support life for any time.

The sudden escape into a mine-working of a very large volume of fire-damp, the accumulating pressure of which has at length overcome the resistance opposed to it, either by the coal or by the stone which forms the floor or the roof of the mine, and the outrush of which is sometimes accompanied by the ejection of very large quantities of disintegrated mineral, constitutes the most formidable danger connected with this associate of coal, because little or no warning is received of its occurrence, and because the volume of gas suddenly liberated is often so considerable that the most powerful ventilating currents are for a time inoperative, while their very action may be to distribute gas rapidly in the form of an explosive mixture with air, to distant parts of the mine-workings. The volume of gas suddenly set free varies very greatly: sometimes it is so considerable that, even with very powerful ventilation, the workings have not been restored to a safe condition for work, in regard to comparative freedom from fire-damp, until several days after the occurrence of the outburst.

That these sudden emissions of gas have been intimately connected with some of the most appalling disasters which have occurred in coal mines appears beyond question, and there is equally little room for doubt that the firing of shots, or use of gunpowder for blasting coal or stones in mines, has been, in many cases, intimately connected with those disasters.

The occurrence of a sudden outburst of gas is, however, not essential to the production of disastrous results by the firing of powder or other explosives in coal mines. The flame developed by the firing of a powder-shot may, without any favouring circumstances, be projected to a considerable distance beyond the face of the coal or stone in which it is fired, if, as is frequently the case, the force is insufficient to accomplish the fracture of the bore-hole in which the charge of explosive is confined, and the highly heated products of the explosion are entirely projected from the hole, as if the shot had been fired from a gun. Experiments upon an extensive scale made, on this head, by the Commission, have shown that the flame from a so-called *blown-out* shot may be projected to distances of thirty or thirty-five feet, in galleries similar to mine-workings or drifts, and if, as is frequently the case, the small debris of coal, which lies ready to hand in the working places is used to tamp the charge with, the volume of flame from a blown-out powder-shot is very greatly increased in length and volume, and may therefore easily extend to goaves, old working places, or cavities where a fire-damp- and air-mixture may be lurking. This is, however, by no means the only, or even the most prominent, danger which may attend the occurrence of a blown-out shot in even the best ventilated coal mine, quite independently of the possibility of a sudden release of a considerable volume of fire-damp during, and consequent upon, blasting. But before referring to what now appears to be well established as the chief general source of danger attending the use of explosives in coal mines, I must touch briefly upon the means available for searching for fire-damp, and for inspecting the workings of a mine, to ascertain that all is safe before men descend to work, or before shots are fired.

The first effect of introducing a Davy or other safety lamp into an atmosphere containing small proportions of fire-damp is to cause the flame to elongate, the extremity becoming narrow and more pointed as the proportion of fire-damp increases; when the latter approaches a porportion which produces with air an inflammable, and ultimately an explosive, mixture, a pale blue halo or cap is perceptible over the flame, and this increases with an increase in the proportion of gas, until the cage or gauze of the lamp is filled with flame. A Davy lamp of small proportions is generally preferred by the overmen or inspectors for gas-testing purposes; the flame is always reduced to small dimensions, so that slight alterations in size or form may be more readily observed. An experienced operator may identify so large a quantity as 2 per cent. of gas in the air of a mine, but even this is very doubtful, except in the case of exceedingly expert observers, who may perhaps succeed in thus detecting the presence of 1·5 per cent. of fire-damp.

It has, however, now been conclusively demonstrated to be of the greatest importance that responsible persons in coal mines should be furnished with reliable means for expeditiously detecting, without the exercise of any very special skill, smaller quantities of fire-damp than it is possible to identify with certainty, even by the exercise of great skill in the use of a safety lamp. Hence much interest and moment attach to the efforts which have been made from time to time by scientific men to devise sensitive and reliable fire-damp indicators. The late Mr. Ansell applied in several very ingenious ways some results of Prof. Graham's classical researches on the diffusion of gases to the construction of sensitive fire-damp detectors, which, however, did not justify the confidence at first placed in them. The same principles have since been applied, but apparently with no greater success, by several foreign inventors of so-called *Grisoumètres*. The late Dr. Angus Smith and Prof. George Forbes have proposed to detect and estimate the quantity of fire-damp in the air of a mine by ingenious applications of other important principles in physical science, and the acoustic indicator, lately exhibited by Mr. Blaikley, is a very pretty application of the principle utilised in a different way by Prof. Forbes. Various forms of eudiometrical apparatus have been constructed with the same object: the variations in the density of

air due to the presence of different proportions of fire-damp have been made the basis of other gas-indicating apparatus; a test-lamp has been constructed to furnish a flame when burning alcohol, which is much more sensitive than the oil flame of an ordinary safety lamp; and an electro-photometric test apparatus has been devised by Mr. E. H. Liveing, which appears to have been the most thoroughly practical form of gas-indicator shown at the recent Exhibition.

The importance of being able to recognise very small proportions of fire-damp in air has become specially evident, since the fact has become thoroughly established, by recent careful and comprehensive investigation, that when fire-damp is present in the atmosphere of a mine, in proportions greatly below those necessary to produce a feebly explosive, or even barely inflammable mixture, it may yet constitute a most formidable source of danger, by its co-operation with the dust which exists, in more or less abundance, in every mine-working.

The fact that coal-dust adds considerably to the disastrous effects of fire-damp explosions, was noticed already more than 80 years ago; but Faraday and Lyell were the first to demonstrate, forty years ago, how important a part might be played by coal-dust, in aggravating and extending the destructive effects of fire-damp explosions. When investigating a serious explosion which occurred in the Haswell Colliery in 1844, they observed many signs of the coal-dust being partly burned, and partly subjected to a charring or coking action, by the fire-damp explosion. Their lucid published account of the evidence that coal-dust may play an important part in the effects produced by mine-explosions covers much of the ground gone over by recent workers and writers on the subject, and affords a curious illustration of the ease with which the work of the most illustrious men may be overlooked or forgotten, even by those who should be specially interested in informing themselves of the existing state of knowledge on the subject. Thus, several well-known French mining engineers published, many years after Faraday and Lyell's work, observations, as new, which were simply confirmatory of those philosophers' original statements and conclusions.

Messrs. Galloway and Friere Marreco, but especially the former, have added importantly to our knowledge of the probable behaviour of dust in mines on the occasion of explosions. Mr. Galloway, who performed experiments upon a considerably larger scale than had previously been the case, was certainly the first to enunciate the conclusion that a small proportion of fire-damp is essential to impart to a mixture of air and coal-dust the power of propagating flame, though he afterwards concluded that fire-damp is altogether unnecessary for the conveyance of flame, with explosive effects, by a mixture of dry coal-dust and air.

The more recent results of other workers in this direction have, however, conclusively demonstrated that while some very highly inflammable coal-dusts may, when raised and mixed with the air by the force of a blown-out shot, become inflamed, and carry flame to considerable distances, with a rapidity and violence of action similar to that of a fire-damp explosion, the extent to which flame is propagated, by most descriptions of coal-dust, in the complete absence of fire-damp, is very limited.

In a series of experiments which, after the calamitous accident in Seaham Colliery in the autumn of 1880, I was requested by the present Home Secretary to carry out with coal-dusts, it was conclusively established that the proportion of fire-damp required to be present in the air of a mine, to bring dust readily into operation as an explosive agent, when thickly suspended in the air, may be even decidedly below the smallest amount which a practised eye can detect by means of a Davy lamp. Various other points of interest were established by this series of experiments.

The more extensive experiments subsequently made by the Commission, in large mine galleries, demonstrated that with a very highly inflammable dust suspended in the air in which no trace of hydrocarbon gas was present, a blown-out shot could produce ignitions which would extend as far as the mixture of air with sufficient dust to maintain flame extended.

Important experiments upon a very large scale, which have recently been carried out by the Prussian Fire-damp Commission, at Neunkirchen, in the Saarbrücken district (see NATURE, vol. xxxi. p. 12, and vol. xxxii. p. 55), have thoroughly confirmed and also considerably extended these results.

It appears now to be well established that the considerable volume of flame and rush of gas produced by a blown-out shot is indispensable to the attainment with certainty of any of the dangerous effects of coal-dust. Inasmuch, however, as blown-out shot are of very common occurrence in blasting operations, it is evident that in dusty mines there is a frequent liability to the production of a more or less extensive ignition or explosion of coal-dust, at any rate when even only very small proportions of fire-damp exist in the air of the mine. It will be seen, therefore, that it needs not a sudden outburst or accidental liberation of fire-damp in considerable quantities to cause the flame which may be projected into the air by the firing of a powder-shot to bring about extensive explosions, or ignitions, spreading over large areas, and possibly communicating to distant accumulations of explosive mixtures of gas and air in old workings.

These most serious dangers, arising chiefly from the use of powder in coal mines, have received the anxious attention of the Commissioners, who have, in the first place, considered how far it might be practicable to prescribe effectual means for removing or counteracting the elements of danger presented by the existence of dust accumulations in mines where it may be impossible to guard against the distribution of small proportions of fire-damp through the air.

The possible substitution for gunpowder of other explosive agents which may be applicable to the kind of work performed by it in coal-mines, has naturally also received much attention. A reduction in the volume of flame produced by gunpowder when used as a blasting agent has been effected by modifications in its composition, but the best result attained until recently in this direction had not materially reduced the danger of using powder in the ordinary manner. Some promising results are, however, said to have been quite lately attained in Germany with a special powder produced by the original maker of the now celebrated cocoa powder, the publication of which is looked for with much interest.

Special forms of gun-cotton were prepared for use in coal in the early days of the improvements made in its preparation; but the large proportion of the inflammable and poisonous gas, carbonic oxide, which its explosion furnishes, prohibits its employment in this direction, even in the form of preparations coming under the head of *nitrated gun-cotton*, which yields comparatively small proportions of carbonic oxide.

Nitro-glycerine contains actually more oxygen than required for the complete burning of its constituents, carbon and hydrogen, and hence its detonation in the open air is attended only by the appearance of a lightning-like flash of light. When diluted with an inert non-combustible material, as in dynamite, its detonation raises to a high red heat the particles of mineral matter with which it is mixed, many of which are, therefore, projected in a glowing state, like a shower of sparks, if the dynamite be fired in a strong shot-hole. Even with Nobel's blasting gelatine, the latest and most powerful explosive, a blown-out shot may be attended by the projection of some glowing particles, either of the tamping or detached from the blast-hole.

The Commissioners have satisfied themselves by many experiments that an explosive mixture of gas and air may be exploded by the projection into it of such sparks, and that they may even occasionally produce ignition, when projected into air containing only a small proportion of fire-damp, but in which coal-dust is thickly suspended.

The outline which I have given you of the dangers attending the use of explosives in coal mines, and of the apparently unsurmountable difficulties attending any attempts to approach immunity from the two great elements of danger naturally existing in a very large proportion of coal mines, namely, fire-damp and dust, will probably lead you to the conclusion that there is but one effectual method of dealing with the serious question of accidents due to explosions in coal mines, namely, that of enforcing the exclusion of the use of explosives in coal mines.

In the House of Commons debate of June, 1878, Mr. MacDonald, while acknowledging that the provisions of the Coal Mines Regulation Act of 1872, for prevention of accidents through the use of gunpowder in fiery mines, had been productive of great good, insisted that these regulations were insufficient to guard against fire-damp explosions, and referred, in illustration, to the fact that the firing of the shot itself might liberate a large quantity of gas, which no previous inspection would discover. He urged in the strongest terms that, until blasting in any fiery mine were absolutely prohibited, there must be a continual recurrence of terrible disasters; and, in the debate which followed, there was a general consensus of opinion among the speakers most competent, from personal experience,

to express a decided view on the subject (such as Mr. Burt, Sir G. Elliot, and the late Mr. Knowles), that blasting should be prohibited, at any rate in fiery mines. It was admitted that the cost of working coal would be much increased by the enforcement of the suggested prohibition, and the majority of competent witnesses examined afterwards by the Royal Commission maintained that the abolition of shot-firing in coal-getting must be attended by very formidable difficulties, and must, in fact, cause the closing of many pits.

I have shown that even the comparatively very small amount of fire-damp which may, at any rate occasionally, pervade the air in portions of mine-workings where thorough ventilation is most effectually provided for, and may escape detection, suffices to determine the production of a disastrous explosion, if, under these circumstances, a blown-out shot occurs where an accumulation of dust exists; and that it is even possible, in the complete absence of fire-damp, for a blown-out shot to give rise to an explosion in a very dusty working or mine, where the coal is of a specially inflammable and sensitive character. Such being the case, the fact cannot be ignored that last year's decision of the late Home Secretary—which raised consternation in many mining districts—to prohibit the firing of shots in any colliery within a period of three months after the existence of gas had been there reported (while the workmen were in any part of the mine), is far from affording the contemplated protection against disaster resulting from the use of explosives *in the ordinary manner*.

This most grave aspect of the question has received the anxious attention of the Commissioners, who would not have considered themselves justified in relinquishing their work until they had practically investigated, as far as in their power, any measure or suggestion appearing to afford promise of aid in furnishing definite replies to the following important questions:—

(*a*) Whether sufficiently efficient substitutes for explosives exist to warrant the assertion that their abolition need not interfere very materially with the reasonably profitable working of collieries;

(*b*) Whether, therefore, it is practicable to limit their use strictly to localities where the absence of every possible risk of explosion can be demonstrated; or

(*c*) Whether any modifications in the ordinary method of using explosives in mines can be so confidently relied upon to guard against, or overcome, certain dangers attendant upon blasting operations in collieries, that it may be practicable to clearly define and lay down certain conditions which will insure the safe use of explosives, either generally, or in all but special cases, which can be precisely defined.

As regards the first question:—The power and efficiency of recently improved mechanical appliances for bringing down coal or for driving headings or crossways, warrant the sanguine expectation that compressed air and even manual power may be, at no distant day, brought to bear so advantageously in mines where fire-damp occurs, as to render it no great hardship to dispense with the use of explosives in some of the work where at present they are considered indispensable.

The considerable and very rapid increase in volume which freshly-burned quicklime sustains when slaked, led, many years ago, to attempts to apply it to the bringing down of coal; but the idea did not assume a really practical form until Messrs. Sebastian Smith and Moore worked out a simple method of applying the lime so as to insure the effective operation of the disruptive force which it is capable of exerting, and to utilise the considerable heat, developed by the union of the lime with water, in the rapid generation and super-heating of steam in somewhat considerable quantity, thus supplementing, in an important manner, the force exerted by the expansion of the lime. The public has been made familiar, in last year's and this year's Exhibitions, with the general nature of Messrs. Smith and Moore's lime cartridges. The Commissioners witnessed their performances at Shipley Collieries soon after their successful elaboration, and the results of subsequent inquiries and experiments have convinced them that, for coal-getting, the lime process can be, to a large extent, substituted for powder, and that its employment, while securing comparative immunity from danger, is unattended by any important practical difficulties.

It has received extensive trial in many of our mining districts, and also on the Continent, and has already taken firm root in some parts of Staffordshire, Yorkshire, and Derbyshire. Its elaborators do not contend that it affords the means of dispensing with the use of explosives, or of specially powerful mechanical appliances, in the removal of stone, or even in some very hard coal; but it is certain that in many collieries, where the prevalence of fire-damp renders the use of the safety lamp imperative, the replacement of shot-firing by lime-cartridges, while unattended by any increase in the cost of getting the coal, would reduce the risk of explosions to those arising from carelessness, or from what should now become the very remote contingency of the use of unsafe or defective lamps.

The idea has been entertained that, by surrounding or covering the charge of powder in a shot-hole with some material which evolves vapour of water, or carbonic acid, when exposed to sufficient heat, these would be liberated by the firing of the shot in sufficient quantity and with sufficient rapidity to extinguish flame and sparks projected by it; but the authors of such suggestions have failed to realise the fact that the exposure of these substances to heat on the firing of a shot would be almost instantaneous, and would therefore leave, at any rate, the greater proportion practically unaltered.

It was suggested by me to the Commissioners that possibly the sudden liberation of carbonic acid, confined in the liquefied state, and placed either over or under the charge in a shot-hole, might prove effective in extinguishing flame and sparks, and a number of experiments have been made in this direction, with considerable, though not complete, success.

Dr. McNab was the first to put into practical execution the idea of using water tamping, in the form of a long cylinder filled with the liquid and placed over the powder charge; with the twofold object of extinguishing the projected flame and sparks, and of diminishing, by dispersion of the water in the immediate vicinity of the shot, the persistence of the powder smoke, which is a source of much inconvenience and loss of time. While it has been demonstrated that decided economy in time does result from the more rapid clearing of the air from smoke when the water tamping is used, many careful experiments conducted for the Commission have shown that no reliance could be placed upon the extinguishing power of water, applied in the way originally suggested by Dr. McNab.

In 1879 I suggested to the Commission a plan by which possibly the more violent explosives, of the dynamite class, might be safely and efficiently applied to the getting of coal, based upon the principle of distributing the force developed by the detonation of small charges over a considerable area through the agency of a column of water, within which the detonated charge was confined. This principle, which has since received important applications in connection with military service, appeared applicable to effect a modification of the shattering action, which renders the violent explosives inapplicable to coal-getting, when used in the ordinary manner, their effects being thus assimilated to those of powder, while the sparks and highly-heated gases projected by a blown-out shot might be effectually quenched by the water which would envelope them at the instant of their projection.

Experiments carried out at Wigan in 1880, demonstrated that the coal brought down by small charges of dynamite inclosed in water compared very favourably with the best results furnished by full powder charges, and these results have been fully confirmed by trials since carried out for the Commission in South Wales. Absolute immunity from danger of the ignition of an explosive gas-mixture by a blown-out shot of dynamite or similar explosive agent was not found to be secured by this system of blasting; such was the case, however, then the blown-out shot was projected into air containing fire-damp in proportions approaching that of an explosive mixture, and in which a very inflammable coal-dust was thickly suspended. It has also been found, in the Commissioners' experiments, that the superposition of the water-tamping, according to Dr. McNab's original plan, over a dynamite charge, appears to afford security against the ignition of a dust-laden mixture of air with a somewhat considerable proportion of gas.

Even while actively engaged in the completion of their Report, the Commissioners are still pursuing this subject experimentally, with the desire of furnishing, as far as in their power, decisive and thoroughly reliable data regarding the amount of security which appears to be afforded, by these methods of working, against the most prominent and prevalent sources of danger in connection with the use of explosives in coal mines; and—while I have been engaged upon this address—a still more simple method of applying water to counteract the dangers arising from blown-out shots has suggested itself to Mr. Galloway,—preliminary experiments with which have furnished most important results.

I have now attempted to give you an outline of the progress made within the last few years towards a thorough comprehension of the nature and causes of those dangers which most prominently direct public attention to the perils of the miner's calling—and of the advances already made, and rapidly progressing, towards the provision of the miner with really safe and efficient underground illumination, with efficient substitutes for explosives for a large proportion of the work connected with coal mining, and with safe methods of using explosive agents where these cannot be dispensed with; so safe that the terrors which have attended blasting in mines may be confidently expected speedily to fade away. I venture to think it will have demonstrated that we have made most satisfactory and important progress in all of these several directions, thanks to the labours of professional associations, of scientific and practical experts, and, I think I may also say, thanks to the exertions of the Royal Commission on Accidents in Mines.

I have been led to refer more fully than I had first intended to the work performed by the Royal Commission—the results of which, in detail, will shortly be in the hands of the public—because I felt sure that the members of the Society of Arts would take a most lively and sympathetic interest in the labours of men, who have not allowed themselves to be discouraged by unjust attacks and ignorant criticism, from endeavouring to carry to a useful termination the arduous work which they cheerfully took upon themselves.

The Commissioners have been silent while hard things have been said of them; but it were idle to deny that they have acutely felt the injustice reflected upon them by some writers in the public Press who, while posing as judges or philanthropists, have not earned for themselves, by knowledge acquired, or by work performed, the right to criticism.

Thirty years' personal experience of the work of experimental Committees has taught me that *ad interim* reports are not unfrequently worse than valueless, and this would certainly have been the case had the Commissioners attempted to make any so-called progress reports, because conclusions, or suggestions, might have been put forward in them which would have had to be afterwards recalled, or incomplete data given, which might have been misleading, and, therefore, even dangerous.

As regards the question of the unsafe nature of certain so-called safety lamps, however, I have pointed out that the Commissioners, just five years ago, reported to the Home Secretary in no hesitating terms, in the belief that their statements would have been published,—and it is no fault of theirs that the public was not informed of their strongly-expressed conclusions on this subject, but has been, on the contrary, recently told in the *Times* by a well-known mining engineer that the results of the Royal Commission's labours "have not even extended to the official condemnation of the known unsafe lamps."

The daily journals have at any rate chronicled the activity of the Commission by recording the dates and *locale* of their frequent meetings,—and have been cognisant, therefore, of the fact that their place of work was easily accessible. This being so, it is somewhat matter for surprise that the writer of very condemnatory paragraphs in an editorial article, suggested by correspondence published in the *Times* last June, should not have cared, in the first instance, to inform himself, however imperfectly, of the kind of work upon which the Commission was engaged, and to take that opportunity of seeking some little correct information on the subjects with which his graphic pen was directed to deal. Had he done so, he would scarcely have instructed the public that "a huge majority of colliery accidents arise from explosions;" that "coal mines generate an explosive gas, which, when collected in a quantity, and exposed to a flame, ignites, and blows into fragments the workings in which the vapour and flame meet;" "that every coal mine has its explosive gas," or that "often the miner has opened the door of his lamp to light up the cavern, already perhaps darkening with the heaviness of a gas-laden atmosphere." I will do him the justice to believe that he would not have felt disposed, after even very brief inquiry, to indorse as "not exaggerated" the declaration of the "strenuous and benevolent correspondent," Mr. Ellis Lever, "that the delay in the issue of the Commission's Report was "to the eternal discredit of Royal Commissions."

After all, however, it rests entirely with the public Press to decide for itself whether the ends it has in view are such as to render it desirable to seek for correct information before administering public condemnation.

But, with a public official, especially when connected with the very Department of State most directly concerned in the work of the Commission, the case is very different; and it is scarcely to be credited that the gentleman intrusted with reporting to the Home Secretary upon the circumstances attending the explosion last summer, at Clifton Hall Colliery, should not have thought it worth his while to ascertain, by inquiry, which could not but have been of immediate service to him, whether the delay in the completion of the Commissioners' Report was "unaccountable."

To this Society, which has always distinguished itself by its encouragement of earnest workers, and by its just judgment of their labours, I have ventured, as one of its members, to make these comments, which could not be uttered by me in my capacity as a member of Her Majesty's Commission, whose duty it is simply to report the results of their labours when they have, to the best of their judgment, fulfilled the duties imposed upon them.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, November 19.—Abstract of "Report on a Series of Specimens of the Deposits of the Nile Delta, obtained by the recent Boring Operations." By J. W. Judd, F.R.S., Professor of Geology in the Normal School of Science and Royal School of Mines. Communicated by order of the Delta Committee.

Neither of the borings made for the Royal Society, under the superintendence of the engineers attached to the army of occupation in Egypt, appears to have reached the rocky floor of the Nile-Valley, nor do the samples examined show any indication of an approach to such floor. What were at first supposed to be pebbles in one of the samples from Tantah, prove on examination to be calcareous concretions ("race," or "kunkur"). Nevertheless, these borings appear to have reached a greater depth than all previous ones in the same district with one or two exceptions. The deepest of the three borings now reported upon have been carried to 73 and 84 feet respectively.

The samples from these borings, like those examined by Mr. Horner, show that the delta-deposits all consist of admixtures, in various proportions, of blown-sand and alluvial-mud. I can find no evidence to support the suggestion made by Sir J. W. Dawson, F.R.S., from a hasty examination of the specimens, that "at a depth of 30 or 40 feet the alluvial mud rests on desert sand;" on the contrary these borings, like those of older date, show that the deposits of the Nile Valley consist of a succession of different beds in some of which sand, and in others mud, forms the predominant constituent.

The *sands*, when separated from the mud by washing, are found to be made up of two kinds of grains, the larger being perfectly rounded and polished, while the smaller, on the contrary, are often subangular or angular.

The larger and well-rounded grains may be described as microscopic pebbles; their surfaces are most exquisitely smoothed and polished, and their forms are either globular or ellipsoidal. In size they vary greatly, being occasionally as large as a small pea. They only very occasionally exhibit traces of deposits of iron-oxides upon their surfaces.

Embedding these grains in Canada balsam, and examining them by transmitted light, with the aid of the polariscope, we are in nearly all cases enabled to determine their mineral characters. The majority of the grains consist of colourless quartz, though occasionally rose-quartz, amethystine quartz, citrine, and smoky quartz also occur. This quartz exhibits unmistakable evidence of having been derived from granitic rocks; it is constantly seen to be traversed by bands of liquid- and gas-cavities, and very frequently contains numerous black hair-like inclusions (rutile ?). Much more rarely we detect grains of quartz which consist of aggregates of small crystals, and are evidently derived from metamorphic rocks. With the pure quartz grains we find also a considerable number of rounded particles of red and brown jasper and of black Lydian stone, with fragments of silicified wood.

But in addition to the different varieties of quartz, particles of felspar are found in considerable abundance among these large rounded grains. What is very remarkable about these felspar-grains is the slight traces of kaolinisation which they exhibit; they are, in fact, almost as fresh and unaltered as the grains of quartz themselves. Ordinary orthoclase and microline are

abundant, while plagioclase felspar is comparatively rare. With the rounded grains of quartz and felspar, a few examples of hornblende and other minerals, including jade, also occur.

But far greater is the number of mineral species represented in the smaller subangular and angular sand-grains. In addition to the minerals already mentioned, I have recognised several varieties of mica, augite, enstatite, tourmaline, sphene, dichroite (cordierite), zircon, fluorspar, and magnetite.

The *mud* is a much more difficult material to study the mineral characters of than the sand, owing to the extreme minuteness of its particles. It is a ver striking fact, however, that kaolin, which constitutes the predominant ingredient of clays, appears to be almost absent from these Nile-muds. Chips and flakes of quartz, felspar, mica, hornblende, and other minerals, can be readily recognised, and it is often evident that the unaltered particles of such minerals make up the greater part, if not the whole mass, of the fine-grained deposits. The mineral particles are, of course, mingled with a larger or smaller proportion of organic particles. Frustules of *Diatomaceæ* occur in these muds, as was pointed out by Ehrenberg, but unless special precautions were observed in collecting the samples it would be unsafe to draw any deductions from their presence.

The striking peculiarities of these sands and muds of the Nile-Valley appear to be capable of a simple explanation. In countries where rain falls and vegetation abounds, water charged with carbonic acid is constantly tending to break up the compound silicates; the silicates of the alkalies and the alkaline earths being decomposed and their constituents removed in solution, while the silicate of alumina becomes hydrated, and is carried away in suspension by water in the form of kaolin. In this way, the felspars and nearly all other compound silicates are affected to such an extent that in most granitic and metamorphic rocks they show evidence of extensive "kaolinization," while the clays derived from them are made up for the most part of crystalline plates of kaolin. But in a rainless country, like Northern Africa, none of these agencies will operate, and the disintegration of the solid rocks is effected by mechanical means; the most potent of these mechanical agents are the heat of the sun, causing the unequal expansion of the minerals which build up the rocks, and the force of the wind, producing constant attrition of the disjoined particles.

This being the case, it will be readily understood that the coarser sand-grains will include felspar and other minerals in a nearly unaltered condition, while in countries where the chemical agents of the atmosphere come into play, such particles would be more or less completely converted into kaolin. In the same way the mud, instead of consisting of scales of kaolin originating from chemical action, will be formed of particles of the chemically unaltered minerals reduced to the finest dust by purely mechanical agencies.

The chemical analyses which have been made of these Nile muds entirely support these conclusions. Instead of containing a considerable proportion of combined water, as do all the ordinary clays, their composition is that of a mixture of anhydrous minerals.

But there is fortunately a kind of evidence, derived from chemical analysis which is of the greatest value from its bearing on the questions we are now discussing—that, namely, which is derived from a study of the composition of the Nile-waters.

It must be remembered that the Nile is a river of a very peculiar and exceptional character. The last tributary which it receives is the Atbara, which falls into it in lat. 17° 38′ N.; from that point to its mouth, in 31° 25′ N. lat., the river does not receive a single affluent; for a distance of 1400 miles it acquires no fresh supply of water except what is brought to it by superficial torrents after heavy rains in Lower Egypt. It has been clearly demonstrated that, after receiving the Atbara, the Nile undergoes a continual diminution in volume in its course through Egypt. This is no doubt in part due to percolation of the water through the delta-deposits, and in part to the water being drawn off in canals for purposes of irrigation; but a large part of this diminution in volume must certainly be ascribed to the great evaporation which must be going on from the surface of the river during the last 1400 miles of its course.

Although we shall not be able to calculate the exact loss of the Nile by evaporation in the course of 1400 miles through one of the hottest and driest regions of the globe, yet we cannot doubt that this loss is enormous. Now the effect of this constant evaporation must be to concentrate the saline matters held in solution, and we might therefore anticipate that the waters of the Nile in Lower Egypt would contain an exceptionally high percentage of saline matters in solution.

But what are the actual facts of the case?

According to the analyses of Dr. C. Meymott Tidy, the Nile contains only a little more than one-half of the proportion of soluble materials which exists in the Thames, the Lea, the Severn, or the Shannon!

A little consideration will show, however, that this startling and seemingly anomalous result is capable of simple and easy explanation. The substances dissolved in the water of rivers is of course derived from the materials composing the rocks of the river-basin, through the action of water holding carbonic acid or other acids in solution.

Hence we are led by the study of the composition of the Nile water to the same conclusion as was reached by the study of microscopical characters of the muds and sands of the delta, that while in the rainy districts of the temperate zones the disintegration of rocks is mainly effected by chemical agencies, in the rainless areas of the tropics the same work is almost exclusively effected by mechanical forces.

The products of these two kinds of action are, however, essentially different. In the former case we have formed crystals of kaolin, which constitute the basis of all the true clays, a large quantity of lime, magnesia, iron, soda, and potash salts with silica passing into solution; while, in the latter case, the several minerals of the rock are simply reduced to fragments of varying size and form, and but little matter passes into solution.

The whole of the observations described in the present report are in entire harmony with this explanation. The comparatively unaltered condition of the felspars and other complex silicates in the sands; the absence of kaolin from the muds, and the presence of the chips and flakes of the unattacked minerals in the muds; and finally the small quantity of dissolved matter in the Nile-water, in spite of the enormous concentration it must have undergone by evaporation—all point to this same conclusion.

In the estimates which have been made of the rate of subaërial denudation in different parts of the globe, it has usually been assumed that this action is similar to what is seen taking place in our own country and in North America. But the observations detailed in this report prove that in rainless tropical districts, where little or no vegetation exists, the disintegration of rocks, though not, perhaps, less rapid than in temperate climes, is different alike in its causes and in its products.

It has often been pointed out by chemical geologists that metamorphic action could not have produced many of the schists from sedimentary rocks, for the former are rich in potash, soda, and other materials which have been dissolved out from the latter during the disintegration of the rock-masses from which they were derived. The recognition of a kind of action whereby great masses of sedimentary materials can be produced, rich in those substances which are usually removed in a state of solution, is not destitute of interest at the present time, when the question of the origin of the crystalline schists is one that presses for solution.

Paris

Academy of Sciences, November 30.—M. Jurien de la Gravière, Vice-President, in the chair.—The Vice-President announced the death of the President, M. Henri Bouley, who died on the morning of the same day. The speaker referred in warm terms to the career of M. Bouley, his entire devotion to science, and the courage with which, although suffering from a fatal disease, he continued to the last to fulfil the duties of his office.—Obituary notices of M. Bouley: by M. Hervé Mangon, in the name of the Academy of Sciences; by M. A. Milne-Edwards, in the name of the Natural History Museum; by M. A. de Quatrefages, as Vice-President of the Acclimatisation Society; and by M. Fremy, Member of the Academy.—As a mark of respect for its late President, the public meeting of the Academy was immediately adjourned.

Berlin

Physiological Society, October 30.—Prof. Zuntz spoke on the apnœa of the fœtus and the cause of the first respiration, setting forth the present state of the question, and then passing to consider the assertion of Prof. Preyer, who, by experiments on rabbits and guinea-pigs, sought to prove that it was not the change in the gas of the blood which was the cause of the first respiration, but a stimulus exercised

on the integument. Prof. Zuntz had quite recently, in conjunction with Dr. Cohnstein, made observations on a new-born lamb that, connected by the umbilical cord with the ewe, came into the world completely apnœic, and, notwithstanding that the most varied stimulations were exercised on the skin, continued apnœic for ten minutes long, though in all other respects these stimulations were normally responded to. Not till the placenta had detached itself did the respiration begin. This observation proved with all certainty that apnœa was dependent on the sufficient supply of oxygen, and that the first respiration was induced by a deficit of oxygen. They therefore repeated the experiments of Prof. Preyer, and came to the conclusion that under them the circulation of the blood always suffered disturbance in consequence of the pressure exerted, whereby the supply of oxygen to the fœtus was impaired, and that the fact which Prof. Preyer adduced in support of the accuracy of his view, namely, that the blood of the umbilical vein always appeared of a bright scarlet red, served exactly to disprove it. The brighter blood of the umbilical vein was, accordingly, an argument of a disturbance in the circulation of the blood, in consequence of which less arterial blood reached the fœtus, and, notwithstanding its greater saturation of oxygen, the blood was, therefore, unable, on account of its deficient quantity, to convey the requisite amount of oxygen to the whole blood. The respiratory centre in the brain thus got supplied with blood poorer in oxygen, and when a stimulation of the skin was superadded the first respiration ensued. In the case of the less excitable brain of the fœtus it was necessary that the outward stimulation should supplement the deficiency of oxygen. In the case of the normally born, however, the detachment from the placenta and the absolute want of fresh oxygen sufficed to stimulate the respiratory centre to activity. In the case of the adult, finally, with excitable brain, a slight reduction of oxygen was itself sufficient to excite respiration.—Referring to the beautiful discovery by Mr. Haycroft, of the fact that the ferment of the saliva in the leech prevented coagulation, Prof. Zuntz recommended the use of this ferment of the leech in measurements of blood-pressure, with a view to avoiding coagulation. This substance had the advantage over all other preventives of coagulation, that in no respect had it any toxic effect. Into the tube conjoining the artery of the animal examined with the manometer of the kymographion a T-tube was intercalated, and by its means a cubic centimetre of the ferment of the leech was squirted per hour into the separate fluid. This was sufficient for the marking of curves of blood-pressure for seven hours consecutively, without the least trace of coagulation.—In view of the divergence of opinions prevailing regarding the alimentary value of the peptones—some maintaining that peptone was used as an alimentary deposit in the body, while others considered that only the albumen absorbed as such was capable of being deposited, the peptones getting, on the contrary, further decomposed—Prof. Zuntz had a number of feeding experiments instituted with peptones. A somewhat long series of experiments was executed on a little dog, first with meat, then with peptone furnished from fibrine, next with albumose substances or propeptones, and, further, with lime. The experiment was arranged in such wise that the dog, along with equal quantities of fat and starch, received daily the like amount of nitrogen. The quantity of secreted nitrogen was daily determined, and thereby the deposit of nitrogen ascertained. The dog first got meat for some days, then peptones for some days, next thereafter meat again, and, following thereon, albuminose substances; this in turn was succeeded by meat days again, then lime days, and, finally, meat days anew. The deposit of nitrogen was now found to amount to—(1) with meat diet, 0·502 grammes nitrogen daily; (2) with peptone, 0·584 grammes; (3) with meat, 0·513 grammes; (4) with propeptone, 0·70 grammes; (5) with meat, 0·46 grammes; (6) with lime, – 0·5 grammes; (7) with meat, 0·48 grammes nitrogen. Meat feeding, accordingly, yielded about the same quantity of nitrogen deposit on each occasion of its being used; in the case of feeding with peptone and propeptone the nitrogen deposit was somewhat greater than in the case of meat-feeding, a result explained by the fact that all the nitrogen of meat did not belong to the albumen, but in part appertained to the nitrogenous bases, which could yield no nitrogen deposit. In the case of lime-feeding, on the other hand, a loss of nitrogen for the body was the result. Prof. Zuntz next had a further series of feeding-experiments performed with the peptones occurring in trade. The dog in question received only fat in addition to the nitrogenous nutriment. In the first days, with meat-feeding, a deposit of nitrogen, to the amount of 0·2 grammes daily, was the result; under feeding with Kämmerich's peptone following thereon, the daily deposit of nitrogen was – 0·4 grammes; the meat days, next succeeding, again yielded 0·2 grammes nitrogen in deposit, while the feeding, thereafter ensuing, with Koch's peptone again showed – 0·4 grammes nitrogen in deposit. The series was closed by meat-feeding, which produced 0·3 grammes deposit of nitrogen. The marketable peptones were therefore, notwithstanding the like supply of nitrogen, incapable of producing a deposit of albumen; on the contrary there rather occurred a loss of corporeal albumen, not so great, however, as when the like quantity of nitrogen was partaken in the form of lime. A series of experiments was finally carried out with the marketable peptones on a dog which for a considerable length of time had been fed only with rice and fat, and had thereby been very much reduced in strength. In this case the first day of feeding with Kämmerich's peptone produced a deposit of nitrogen to the amount of 0·6 grammes; in the following days this deposit was less; and soon the nitrogen showed itself at equilibrium. Under feeding with Koch's peptone, too, the animal, which was very much reduced, was maintained at equilibrium in respect of nitrogen.—Dr. Weyl communicated the results of his further investigation into the constitution of the derivatives obtained from cholestearine, which, at a meeting of the Society before the vacation, he had declared to be terpenes. He endeavoured to determine the molecular weight of those carbo-hydrates which, according to the nature of terpenes, had the composition $(C_5H_8)^n$. The vapour density, determined according to the method of Victor Meyer, showed itself in the lead bath not normal. It corresponded with the composition C_5H_8, thus indicating decidedly that a dissociation had set in during the process of heating. Other terpenes also, such as turpentine oil and camphor, yielded results which were not normal and showed a dissociation into the radical C_5H_8, a circumstance which likewise argued the terpene nature of cholestearine. Dr. Weyl was able, finally, to demonstrate the connection of cholestearine with the terpenes by showing that the latter very beautifully produced the well-known cholestearine reaction. Further experiments with a view to determining the vapour density in a vacuum would perhaps yield the molecular weight of these interesting carbohydrates.

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